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PHOTO BY A. G. DAVIS

THE NEW LIBRARY OF THE WELSH PLANT BREEDING STATION AND THE IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS.

In December, 1939, the Bureau moved into its new quarters on the second floor of the Agricultural Research Building, Penglais, Aberystwyth. The offices overlook the town and Cardigan Bay, while the Library, now containing the books of the Welsh Plant Breeding Station, the Imperial Bureau and the Department of Agricultural Economics, faces the grass plots on Penglais.

Those who visited the Bureau in the past, or had occasion to use the Library, will appreciate the great improvement provided by these new quarters. The door at the end of the Library opens into a small research room containing, in addition to book stacks, four special study carrels, for the private use of research students and visiting scientists. The files containing the author and subject indexes of herbage and forage crop literature are housed in a separate room.

RANGE SURVEY METHODS IN WESTERN UNITED STATES

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RANGE surveys have as their objective the furnishing of information necessary for sound range management of each area surveyed. Their primary purpose is to collect data which indicate how much and what kind of use may be made of the range forage crop annually without injury to the forage, soil, or to other natural renewable resources of range lands. The survey systematically inventories the amount of vegetation present and its value to grazing animals. It is concerned fully as much, however, in gathering other facts relative to managing the range resource.

Data from range surveys offer a dependable basis for drafting plans to manage grazing effectively on administrative units such as a national forest, a grazing district or a range in private ownership (**3**). Definite information on important range problems, brought to the administrator's attention as the result of range survey data analysis, stimulates and crystallizes the planning of corrective measures and the following up with effective action. Basic data obtained from surveys assist the administrator to correlate use of range forage with the management of other resources for which he is responsible.

On parcels of range grazed by a single band of sheep or herd of cattle, range surveys serve as the blueprint for future, constructive range management. The data shown in place on maps are guides to numbers of livestock that should be permitted to graze, to periods of time that should be spent in rotation units, to pounds of salt that should be distributed at specific locations, to needs for water development, and to many other management features. Problem areas such as lands seriously eroding, poisonous plant infestations, and excessive concentrations of range rodents, clearly portrayed in the survey, are properly emphasized to the persons charged with handling the grazing and are more certain to be dealt with effectively. Range survey maps and reports are easily converted into effective, graphic implements to aid in correcting range problems on the ground and for keeping account of the progress made in their solution.

Range survey data are of value in county, State, or regional planning programs designed to analyse broad problems and to recommend general lines of action to be taken in their solution. The objective in such planning is to improve existing economic and social conditions, which, on a long-time basis, also involves maintenance

and improvement of natural renewable resources. In western United States, the range resource is everywhere highly important to the economy of the commonwealth, and as such the solution of problems connected with management of the range plays an important part in the planning.

The range management plan emanating from analysis and interpretation of range survey data usually does not approach range problems solely from the resource management standpoint. Effort is made to harmonize efficient harvest of range forage with the social and economic welfare of the population dependent on the range resource for a livelihood. Range survey is, therefore, an instrument designed to aid in solving the many involved problems that arise in the attempt to sustain production of forage and other resources on range land.

The Need for Range Surveys

The range country of western United States lies primarily between the 98th meridian and the Pacific Ocean. Within this area there are estimated to be 728 million acres of native grazing land (**9**). For half a century (1870-1920), this immense area was grazed with increasing intensity, building up to a peak of thirty-two and a half million animal units* in 1920 (**1**). Livestock numbers declined somewhat following the World War, but in 1935, twenty-seven and three quarter million animal units of livestock still depended on the range in whole or in part for forage (**1**).

It is estimated from extensive studies (**2, 9**) that this use, coupled with a distinct downward trend in precipitation from soon after the turn of the century, has resulted in a loss of 52 per cent of the original grazing capacity. This loss, together with an intense present demand for range forage, creates a serious problem that is now generally recognized and which is receiving widespread attention.

The problem of restoring grazing capacity of the western range is made difficult to solve because of varied conditions throughout the vast territory. Wide differences exist in vegetation and soils. Climate, especially precipitation, varies widely between localities and, in the same locality, between years. Droughts, devastating to range plants, occur at frequent intervals. The character of use varies; the southern and central Great Plains and the California valleys and foothills are used yearlong, the northern Great Plains are used spring, summer, and fall, vast areas of desert shrub between the Rocky Mountains and the Cascade-Sierra Nevada chain are used only during winter months, mountain valleys and foothills usually are grazed spring and fall, while mountainous timbered and sub-alpine slopes are usable only during summer months. Ownership of the range is complicated. Individuals or corporations own 376 million acres of grazing land. Administration of grazing on 352 million acres of range publicly owned is divided as follows: The United States Department of the Interior, Grazing Service, 134 million acres; Office of Indian Affairs, 48 million; the United States Department of Agriculture, Forest Service, 88 million acres; other Federal agencies, 17 million acres; States and counties, 65 million acres. It is frequently necessary for a range livestock outfit to graze on lands in several ownerships and in several season-of-use zones during the year's calendar of operations.

*Definition of special terms is presented in the glossary on page **11**.

The solution of such a complex problem by a general application of fixed corrective measures is obviously impractical. It is necessary first to study the problem and to formulate sound plans for its correction on specific range areas. Having worked out solutions on several areas, the results may be correlated into a composite solution for the group, which may mean some modification of individual plans. The range survey method, culminating in effective and well-balanced plans for specific range areas, is designed to assist in the eventual solution of the broad range problem.

Extent of Range Surveys

Considerable progress has been made in surveying the range lands of western United States. As from January 1, 1939, approximately 37 per cent of the total range area has been covered. In round numbers, the Agricultural Adjustment Administration in co-operation with the Forest Service has surveyed 118 million acres of privately owned ranges, the Soil Conservation Service 20 million acres of range also in private ownership, the Office of Indian Affairs in co-operation with the Soil Conservation Service 22 million acres on the Indian Reservations, the Grazing Service 57 million acres on the grazing districts, and the Forest Service 51 million acres on the national forests. Data from the major acreage surveyed on public lands and from surveys on privately-owned ranges made by the Soil Conservation Service have been analysed and incorporated in effective plans for grazing management. Surveys of privately-owned ranges by the Agricultural Adjustment Administration have been largely incorporated into general range management plans for selected counties through the efforts of the Co-operative Western Range Survey project.

Since 1937 a standard procedure has been used in making range surveys*, in naming and designating forage types, in assigning proper-use ratings to plants, and in showing essential management data on maps (**4**). In this manner, the way is paved for close integration in developing sound range management on lands in different ownerships and in different season-of-use zones.

The Range Survey Method

Public agencies engaged in making surveys in western United States recognize two variations of the range survey method as standard and equally acceptable (**4**). These are popularly termed the reconnaissance and the point-observation-plot methods.

The reconnaissance method was originated in 1907 by Dr. James T. Jardine, then an inspector of grazing in the U.S. Forest Service. He was instrumental in the development of the method from 1907 to 1910 and in 1911 used it on the Coconino National Forest in Arizona to make the first range survey on a party basis (**3, 6**). The method as developed by Dr. Jardine is still in use, with minor changes, as a standard procedure (**4**). His idea of determining relative forage value of vegetation types by arriving at an estimate of the percentage of ground covered by vegetation (expressed as average plant density) and also of estimating the percentage density made

*Mimeographed instructions for making range surveys accepted as standard by the interested public agencies can be obtained free of charge by writing to the Division of Range Research, Forest Service, Washington, D.C.

up by individual species (expressed as percentage composition) is the foundation for the method as it is used to-day. Accuracy of results from the reconnaissance method depends largely upon the judgment and observation power of the individual using it, since he must visualize vegetation density and composition on areas seldom less than 10 acres and sometimes as large as a square mile in extent.

The point-observation-plot method was originated in 1932 by Dr. George Stewart and Selar S. Hutchings of the U.S. Forest Service in an attempt to overcome bias and personal error in estimating vegetation density and composition (**8**). In using the method, estimates are obtained of vegetation density and species density on many impersonally selected plots, usually 100 square feet in size. The point-observation-plot method, perfected during the period 1932 to 1936, was adopted as a standard range survey procedure in 1937 (**4**).

Mapping and Describing Range Management Features

The mapping and describing of features important to range management are processes common to both range survey methods. Range survey maps, generally on a scale of 2 inches to the mile, show in place such features as: vegetation types and sub-types; acreage and relative grazing capacity of sub-types; problem areas such as location and extent of accelerated erosion, rodent infestation, and concentrations of poisonous plants; topographic features, especially those affecting movement of livestock; watering places, dependability of water supply and opportunities for water development; existing culture influencing management, such as roads, trails, fences, corrals, buildings, telephone lines, etc.; and land ownership, if important to resource management. These data are supplemented by descriptive written information emphasizing their importance to range management of the surveyed area and in addition reporting upon past and present livestock numbers, class of stock, period of use, livestock distribution and management, condition of vegetation, use of range by game animals, conflict of grazing with other uses, range improvements needed, and recommendations for constructive changes in management and reasons therefor. This written information is compiled in part from pertinent comments entered on write-up forms at the time when each sub-type is examined, and in part from notes taken by the chief of the survey party during a detailed inspection of the surveyed range.

Depicting the location, area, and constitution of vegetation types and sub-types is helpful to range management partly because a tendency exists for range conditions and management requirements to be more or less similar within a type and dissimilar between types, especially between those which exhibit different vegetation compositions. Also, the vegetation sub-type serves as a natural unit, capable of field identification, for building up a grazing capacity estimate for the surveyed range area and for analysing range survey data with the object of formulating range management plans.

A vegetation type is an area of range recognizable by its general aspect. For example, untimbered range dominated by grasses is termed "grassland." areas of range vegetation with an overstorey of coniferous trees are called "conifer," range areas

dominated by sagebrush (*Artemisia* spp.) are known as "sagebrush." Each vegetation type is given a key number and colour. In the foregoing examples grassland types are identified on maps by the number " 1 " and are coloured a bright yellow, conifer types are numbered " 6" and coloured dark green, and sagebrush types are numbered " 4" and coloured stone brown. This simplifies the completed range survey map by substituting colours and key numbers for descriptive type names. In western United States, eighteen vegetation types are recognized in surveying range, each having a standard colour and number. A bright yellow area numbered as "1" is identified as a grassland type, whether it be on a map from New Mexico or from Oregon.

Mapping range vegetation to types based on aspect is too broad for range management purposes. Range surveys, therefore, subdivide vegetation types into sub-types. A sub-type is an area within a vegetation type which is recognizable from other areas by the floristic composition, by the density of vegetation, or by an outstanding range condition, such as poor or unusually good plant vigor. Sub-types bear the standard number and colour of their vegetation type and are further identified by standard symbols signifying the names of the one or two most important species in the sub-type. For example, a grassland sub-type in which bluebunch wheatgrass (*Agropyron spicatum*) and Idaho fescue (*Festuca idahoensis*) are outstanding plants is designated " 1-Asp-Fid " and coloured bright yellow. Sub-types are delineated on range survey maps with dotted lines.

Surface acreage and estimated grazing capacity, generally expressed in cow or sheep months, are also shown for each sub-type on the completed map. For example, the figure $\frac{160}{200SM}$ appearing within a sub-type on the map denotes an area of 160 acres and a grazing capacity of 200 sheep months.

The base map on which sub-types, culture and other important management features are to be drafted may be obtained from maps prepared by the General Land Office which show main drainage courses, section corners and section and township lines, primary roads, and important topographic features such as mountain peaks. If this basic information can be augmented by accurately mapped topography, with contours at not more than 100 feet vertical intervals, typelines and other management features encountered in the course of the range survey may be sketched on the map with greater accuracy. Recently, planimetric maps derived from aerial photographs have been used with great success in range surveys.

When General Land Office maps are used as a base for range surveys, the field examiner usually traverses the area on parallel lines, generally two through each square mile and spaced one-half mile apart. A surveying compass is used for directional control. Distances are recorded by pacing. At every opportunity, direction and distances are checked with section corners. It is possible to locate ground features accurately as they are encountered on or near the survey line with this procedure, but since all type boundaries and other management features must be sketched to a distance of at least one-fourth mile each side of the line, accuracy of mapping diminishes as distance from the survey line increases unless much effort is expended in

traversing. Mapping by plane table (8) to locate types and other features more accurately has been attempted, but has proved too costly a process.

The addition of topographic detail to the base map enables the examiner to sketch more accurately since he is able to locate points distant from his survey line by referring to topographic features. Where relief is bold, such as in mountainous areas, it is sometimes possible to abandon the "strip" method of range surveying and to work "with the country," keeping located by reference to outstanding topographic prominences or depressions recognizable on the base map. This procedure is most desirable, since by permitting greater freedom of travel it allows more thorough inspection of the vegetation and more accuracy and detail in mapping.

If aerial photography precedes a range survey, the examiner is aided by having a planimetric base map which shows drainage and roads in accurate detail. The greatest benefit from aerial photography, however, is the availability of photographic prints developed from exposures made at altitudes of from 18,000 to 20,000 feet and roughly on a scale of 3 to 4 inches to the mile. Although the horizontal scale of these photographs is somewhat distorted because of variations in ground elevation, topographic features and major changes in vegetation are easily discerned. The examiner does his field mapping directly on the photographs and without reference to section or township corners. His location is established with reference to clumps of trees, changes in vegetation, or topographic features readily discerned on the photograph. Type lines may be drawn accurately and with ease because major changes in vegetation usually are plainly depicted on the picture. If sub-type boundaries are not reproduced, they may be sketched rapidly by referring to outstanding features such as trees, roads, or drainage which appear on the photograph. When the locations of sub-types and of cultural features such as water developments and fences have been sketched on the photographs, they may be transferred to the base map planimetrically.

Estimating Density and Composition

After the sub-type boundary has been sketched on the base map, the examiner obtains an estimate of average vegetation density and composition within it. Density, as estimated with either survey method, is the percentage of ground which appears to be covered by foliage when the vegetation is viewed from directly above. In the case of shrubs, density also includes current twig growth. Portions of shrubs or other plants growing beyond the reach of livestock are ignored in density estimates. Two-storey vegetation, such as grasses growing beneath shrubs, is given a density value for each storey if both are available to livestock.

The optimum condition for estimating density is during the period when important range forage plants are at or near their maximum development. It is uneconomical, however, to conduct range surveys for such a limited season. Densities, therefore, must be estimated previous to and subsequent to the maximum growth stage of forage plants, and also in years of above- and below-normal rainfall. In order to normalize the density estimate somewhat, attempts are made to visualize the plant as it should appear at maximum growth in a normal climatic year. Too much mental reconstruction of density has been found dangerous, however, and it is

generally felt that best results are obtained in estimating density with a minimum of visualization.

By the Reconnaissance Method

The procedure in estimating average density and composition of vegetation within a sub-type with the reconnaissance method is accomplished by the examiner going far enough into the sub-type until he is satisfied that he is acquainted with the vegetation on it. He then selects a small, definitely bounded area which he considers to be typical of the sub-type. On this area he estimates the percentage of ground covered by vegetation (density) and checks this by estimating the percentage of bare ground apparent. The two estimates should equal 100 per cent. Having determined the density of all vegetation, he then obtains values for species by deciding what percentage each comprises of the density. These species estimates, known as percentage composition, should total 100 per cent. He then proceeds through the type, mentally evaluating density and composition values as he travels. If important changes in density or percentage composition occur, the examiner checks them against his specific write-up and revises it accordingly. If changes in density and composition are major, he usually selects another typical area and makes a new estimate which he may substitute for the first or average with it. Seldom are more than two complete write-ups of typical areas made to obtain an average for a sub-type with this method. More frequently the first is revised in the light of floristic changes encountered later within the sub-type.

By the Point-Observation-Plot Method

When estimating densities by the point-observation-plot method, the examiner is not concerned with selecting a typical area. Instead he establishes a number of small plots at specified intervals and limits his estimations to these plots. The plots are usually circular in shape and 100 square feet in area. If the examiner is mapping sub-types with the aid of aerial photographs or an accurate topographic map, three to six plots are generally established in sub-types smaller than 20 acres, five to ten plots in sub-types larger than 20 but smaller than 80 acres, and ten to twenty plots in sub-types ranging from 80 to 640 acres. If the examiner is using the "strip survey" method, twenty plots per square mile are usually taken, spaced at intervals of eight chains (528 feet) on two parallel lines that are one-half mile apart.

In estimating density the examiner counts the square feet of ground covered by foliage within the plot, using a square frame of one-foot dimensions as a guide to his estimate. Since the plot area is 100 square feet, one square foot of vegetation is equivalent to a density of one per cent. Density estimates are made for each species which exhibits a foliage cover of 0.5 square feet (0.5 per cent density) or more. The density of all vegetation on the plot is obtained by adding these figures. Averaging values obtained from all plots gives the density of vegetation and of each species in that sub-type.

Computing Grazing Capacity

Forage Factor

Forage factor is the expression of relative forage value of a sub-type. It is a decimal fraction obtained from multiplying vegetation density by its proper use factor expressed in per cent. Proper use factors for range forage species are obtained by research or by careful observation. They are based on the percentage of current herbage production of the various species which is utilized when the range is properly grazed under the best practical range management. The proper use factor for a species does not exceed the use it can withstand each year and still maintain its density and vigour.

To compute the forage factor from data obtained by the reconnaissance method, the percentage compositions of species are multiplied by their proper use factors expressed in per cent (Table 1). These results are added to obtain the weighted proper use factor for the sub-type. The weighted proper use factor is multiplied by the density of vegetation to obtain the forage factor. Forage factor of a sub-type is computed in the case of the point-observation-plot method by multiplying the average densities of species by the proper use factors and adding the resulting figures (Table 2).

Forage Acres

Forage acreage of a sub-type is computed by multiplying forage factor with surface acreage (tables 1 and 2). Forage acreage is a quantitative measure of the sub-type's forage value. A forage acre, theoretically, is an acre of range completely covered with foliage which properly can be utilized completely by livestock. This situation does not exist in Nature, for in the case of dry meadows which may have a complete or 100 per cent density, the foliage can seldom be used more than 80 per

Table 1.—Computation of Grazing Capacity—Reconnaissance Method.

Principal Species								
	Amount			Amount			Amount	
Weeds	In per cent	× proper use factor	Grasses	In per cent	× proper use factor	Shrubs	In per cent	× proper use factor
Bsa	10	4	Asp	10	7	Atr	25	0
Gvi	10	2	Fid	5	3	Ptr	15	6
LUP	20	4	Pse	5	2			
	40	10		20	12		40	6

Estimated density—40 per cent. Weighted proper use factor—28 per cent.
Forage factor—0.112.
Surface acres—100. Forage acres—11.2.
Forage acre requirement—0.5 forage acres per cow month.
Grazing capacity=22.4 cow months.

Table 2.—Computation of Grazing Capacity—Point-Observation-Plot Method.

Species	Species density by plots per cent. Plot Number					Total density per cent	Average density per cent	Proper use factor per cent	Forage factor
	1	2	3	4	5				
Asp	5	5	—	5	5	20	4	70	0.028
Fid	—	—	10	—	—	10	2	60	0.012
Pse	5	—	—	5	—	10	2	40	0.008
Bsa	5	—	5	—	10	20	4	40	0.016
Gvi	5	5	5	5	—	20	4	20	0.008
LUP	10	5	10	5	10	40	8	20	0.016
Atr	15	5	—	20	10	50	10	0	—
Ptr	10	5	5	5	5	30	6	40	0.024
Total	55	25	35	45	40	200	40	—	0.112

Surface acres—100. Forage acres—11.2.
Forage-acre requirement—0.5 forage acres per cow month.
Grazing capacity=22.4 cow months.

cent and maintain the plant cover successfully. Forage acreage, therefore, is always less than surface acreage. The reduction from surface to forage acreage essentially is the elimination of all ground surface except that covered by foliage which properly can be completely grazed by livestock.

Forage Acre Requirement

Having determined the number of forage acres on the surveyed area, it is necessary to develop a factor to convert forage acreage to an estimate of grazing capacity. Such conversion factors are known as forage-acre requirements. True grazing capacity of a range area is the amount of grazing it can support over a long period of years under the proper range management system without injury to the forage or soil resource. The proper level at which to establish grazing capacity, therefore, is not higher than the level of forage production in the average climatic year. In regions where drought recurs, grazing capacity must be based on forage production somewhat below the long-time average as a precaution during dry periods against livestock starvation and serious injury to range.

Range surveys may have to be made regardless of climatic conditions, and consequently plant densities above or below average may have to be measured. This fluctuation in density value results in a determination of forage acreage which is higher or lower than normal, depending on the climatic condition prevailing. In order that the calculation of current forage acreage on a range area be reduced to an estimate of its true grazing capacity, it is essential that the forage-acre requirement for each range survey project in each year be developed by careful study. Forage-acre requirements known to be adequate on comparable areas, and results from long time grazing capacity research are aids to studies of this nature.

The general procedure in developing a forage-acre requirement is to select a pasture or well controlled range unit within the surveyed area on which numbers of livestock grazed have been accurately recorded for several years, preferably ten or more, and which exhibits vegetation and soil in good condition. The average number of livestock grazed and the average grazing period are determined and are usually reduced to an expression of average grazing use in terms of cow months or sheep months. The forage acreage of the pasture or unit as obtained by the range survey is divided by this use figure to obtain the forage acreage required to support a cow or a sheep for one month. If this forage-acre requirement can be determined from several such pastures or range units, it provides a better basis than a single area. This factor may then be used to convert forage acres on the remainder of the surveyed area to estimates of grazing capacity (tables 1 and 2). Reduced to a formula, grazing capacity as estimated by range surveys is computed as follows :—

$$\frac{\text{Density} \times \text{Proper use rating} \times \text{Surface acres}}{\text{Forage acre requirement}}$$

Application of Range Survey Data

The purpose of range surveys re-stated, is to provide sound data from which to derive a plan for managing the use of a range in such a way that its resources are conserved. The range management plan, to be effective, must be followed up with vigorous field action. A management plan based on painstaking surveys may become worthless through lack of prompt, effectual action, for if deleterious processes are allowed to continue unduly after the inventory is made, the inventory's value naturally is diminished. By the same token, analysis of the survey data should lead to practical, workable solutions of range problems, and drastic recommendations should be made only if clearly required in the interest of the resource. In some instances, surveys have failed to meet their objective because the analyst overlooked the need for practicality in his conclusions.

It is vital, therefore, that the individuals who have made the survey, and those responsible for managing the range, work closely in the process of analysing the data and of formulating plans for improving range management practices. It is also important that the stockmen who manage the livestock on the range should be familiar with the project and sympathetic with the results. After the plan has been put into effect, whole-hearted co-operation between these three is necessary to insure the carrying out of its provisions to the fullest extent possible.

Most controversy over the results of range surveys centres on their estimates of grazing capacity, especially if these estimates happen to be substantially lower than the number of livestock being grazed on the range in question. Admittedly, the survey method is subject to error in obtaining the estimated figure, but the results of range surveys in arriving at or near grazing capacity have been surprisingly good. In every case, however, the survey should be followed by an intensive, objective range inspection in the following year to decide whether the results obtained are sound. If careful study indicates the grazing capacity estimate for the area to be low or high, the survey is in no sense invalidated, for the relative capacity

values between different parts of the area are still usable and the entire capacity estimate may be raised or lowered as found to be necessary.

Apart from obtaining a clue to grazing capacity, the range manager finds in the range survey data a most systematic and impersonal appraisal of range values, range problems and range conditions. Installation of better range management practices to date has been seriously handicapped through lack of these fundamental data which would have been available had the range been covered with carefully conducted surveys. The recent, marked increase in coverage of western grazing lands by range surveys cannot but add to the effectiveness of future resource plans and management.

Glossary

1. ADMINISTRATIVE UNIT: A range area, generally in one ownership, all parts of which have a common management policy and similar management objectives.
2. ANIMAL UNIT: Use of forage equivalent to the amount grazed by a mature cow in one year. Five sheep, five goats, or one horse are generally considered equal to one cow for range grazing.
3. BASE MAP: Any map used on which to superimpose data gathered by a range survey.
4. CO-OPERATIVE WESTERN RANGE SURVEY: A co-operative undertaking by several public agencies to correlate and co-ordinate their range survey efforts with the object of formulating management plans and solving range problems regardless of land ownership.
5. COW MONTH: The amount of range forage a mature cow will consume in one month.
6. CULTURE: The artificial (man-constructed) features shown on a map as distinguished from natural features.
7. FORAGE ACRE: A theoretical acre entirely covered with foliage which properly can be used completely by grazing animals. A quantitative expression of forage value obtained from multiplying forage factor by surface acreage.
8. FORAGE-ACRE REQUIREMENT: The amount of forage, expressed in forage acres or fractions thereof, needed to sustain a mature grazing animal for a specified period without injury to the range resource.
9. FORAGE FACTOR: The result of multiplying average density of range forage on a specified area by its proper-use factor, thereby obtaining an expression of relative forage value.
10. FORAGE VALUE: The value of a range plant or a range area for grazing purposes based on the amount of foliage which will be used by livestock under proper range management.
11. GRAZING CAPACITY: The maximum number of livestock which a range area will support under the most suitable management over a period of years without injury to soil, forage, tree growth or watershed, or unwarranted interference with other services of the land.
12. PLANIMETRIC MAP: A base map upon which drainage courses and major topographic features are derived from aerial photographs of the area.
13. PLANT COVER: The complete vegetation of a range area.
14. PLANT DENSITY: The amount of ground surface which appears to be completely covered by foliage within easy reach of livestock when the vegetation is viewed directly from above. Usually expressed in percentage or its decimal equivalent.
15. PROPER USE FACTOR: The degree to which the herbage within easy reach of livestock is grazed when the range is properly utilized under the best practicable management.
16. RANGE: Defined by Webster's International Dictionary as "A sparsely populated . . . . . region over which cattle, sheep, and other livestock may roam and feed." Range in the United States is usually considered to be land which produces native forage suitable for grazing by domestic livestock and which, because of relatively meagre precipitation

or other adverse climatic conditions, or rough topography, or the lack of water for irrigation, cannot be used successfully for any other form of agriculture.

17. RANGE LIVESTOCK OUTFIT: The holdings of a range livestock operation, including the range lands, livestock, headquarters farm or ranch, and the necessary equipment for operating the enterprise.
18. RANGE MANAGEMENT: A system of harvesting range forage with grazing animals which is generally designed to be harmonious with the growth requirements of range plants.
19. RANGE RESOURCE: The natural, renewable resources of wild land which is used for grazing purposes. These generally are forage, soil, and watershed values and may also include recreational value, big game, and timber.
20. ROTATION UNIT: A subdivision of a range used by a single band of livestock. These subdivisions are made in order that they may be grazed in rotation during the season to promote better conditions for plant growth and reproduction.
21. SEASON-OF-USE ZONE: An elevational or latitudinal belt wherein the climate exerts such an influence on inception and cessation of plant growth that the range can be grazed only during a certain period of the year.
22. SHEEP MONTH: The amount of range forage a mature ewe will consume in one month.
23. SURFACE ACREAGE: The area expressed in acres encompassed within the boundaries of a vegetation type or within such other boundaries as may be useful in managing a range area.
24. VEGETATION SUB-TYPE: A subdivision of a vegetation type differing from the remaining portions in floristic composition, density of vegetation, or range conditions.
25. VEGETATION TYPE: An area of range recognizable from other range areas by the aspect of its plant cover.
26. WATER DEVELOPMENT: The procurement or enlargement of a water supply for livestock.
27. WRITE-UP: The notes taken for a vegetation sub-type in making a range survey, including estimates of vegetation density and composition, appraisals of range and soil conditions, and observations of important management features.

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REVIEWS

BIOCHEMICAL APPROACH TO GRASS PROBLEMS

[Reviewer : R. O. Whyte]

In an article to the *Journal of the American Society of Agronomy* 31. No. 9. 751-60. 1939, A. G. Norman, formerly of Rothamsted Experimental Station and now Professor of Soils, Iowa Agricultural Experiment Station, Ames, Iowa, U.S.A., raises a number of points of wide interest and application.

Norman states that in its biochemical aspects, as in others, the pasture problem is a peculiarly complex one. Much of the biochemical work on forage crops in recent years has been concerned quantitatively with minor constituents, such as the mineral constituents, carotene, and the vitamins, and lately also with essential amino-acids. " There seems to be a regrettable tendency in considering the quality of grass to look chiefly at the nitrogen content and to imply that young grass is so much better than mature hay simply because of the higher content of protein it contains. Beasts do not live by protein alone, and even in the best grass the protein is a relatively small part of the whole. There appears then to be a real need for a further study of the energy-supplying constituents, which together comprise by far the greatest proportion of feeds, an examination of their relative availabilities, the prediction of their digestibility, and the study of management practices that will maintain a profitable compromise between yield and quality. This means that it will be necessary first to break down some of the complex pasture problems into simpler units which may separately appear not to be very practical, but which taken together should give what is wanted. The changing composition of the plant with age, the effect of fertilizers, and management, all ought to be determined independently first."

A strong case is made out for the direct determination of cellulose and lignin as a minimum requirement in studies of pasture herbage composition. " In addition it would be desirable that an attempt should be made to separate the other major carbohydrates, both structural and reserve, in order that the percentage of material unaccounted for shall be as small as possible, and not a composite of errors in method and technique as at present."

Certain experiments made at Rothamsted on the changing composition of grasses with age and fertilizer treatment are quoted to illustrate the use of these newer analytical procedures and the breakdown of the pasture problem into the equivalent of pure cultural studies.

" Arising out of the data presented, the following points seem to call for attention and to be capable of solution by an extension of the direct methods of determination just described :

" First, what is the nature of the primary and secondary carbohydrate metabolism of grasses ? Is fructosan a major temporary reserve only in ryegrass, or is it to be found generally in many species ? What relationship, if any, is there between fructosan formation and storage and the rapidity of new growth following cutting or grazing ? Are there other reserve carbohydrates as yet unidentified ?

" Second, what is the influence of lignification or lignin deposition on the digestibility of herbage ? Are the advantages of feeding young grass so exclusively confined to the higher protein content and greater digestibility of the cellulose as

has been supposed, or may not the replacement of much soluble polysaccharide by insoluble structural constituents be also concerned?

"Third, what is the nature of the hemicelluloses of grasses? How may they be determined, and what role, if any, do they play in affecting the value of the herbage? Can they act as reserves, as has sometimes been asserted, or should they properly be regarded as structural constituents and consequently out of circulation so far as renewal of growth after cutting is concerned? Because of limits of time, this group has not been discussed, but it should perhaps be stated that in all the samples mentioned, the hemicelluloses were probably quantitatively more important than the lignin.

"This list of questions could be considerably extended, particularly if the nitrogenous constituents are also included. Most of the questions are quite fundamental to a fuller understanding of grasses and the proper management of grassland. Their solution depends on the further development of biochemical methods in this field and the abandonment of empirical procedures as research tools."

ROOT NODULES AND MYCORRHIZA OF ALPINE PASTURES

[Reviewer: G. M. Roseveare]

Studies were made in 1934-35 in woodland composed of (a) *Fagus silvatica*, at an altitude of 800 to 1,300 m., (b) *Larix decidua*, altitude of 1,200 to 1,850 m., and (c) *Abies alba*, altitude of 1,300 m.; in clearings of the said woodlands, and also in alpine pasture, beginning above the larch area at 1,900 m. to approximately 2,600 m., (C. E. Malan. *Ann. Bot., Roma.* 21. 465-94. 1938). In the beech wood were found *Lathyrus montanus* and its variety *tenuifolius*, *Vicia* spp. (peculiar to the beech zone), namely, *V. cracca*, *V. sativa*, *V. sepium*, *Trifolium medium*, *T. repens* and its variety *pallescens*, *T. pratense*, *Lotus corniculatus*, *Cytisus nigricans* and *C. hirsutus* (rare, appeared to be localized at 1,100 m.), and *Genista germanica*. In the larch wood were found *Lotus corniculatus* as the most common legume, *Trifolium medium*, *T. repens* and var. *pallescens* (more limited locality); in the higher parts, towards 1,750 m., *T. alpinum*, *T. alpestre* and *T. pratense* var. *nivale*. None of the legumes studied were found in the fir woods, where conditions are unfavourable for any form of vegetation. In the alpine pasture *Lotus corniculatus* was frequent from 1,200 m. to 2,450 m., *Genista germanica* found its upper limit at 1,400 m., some *Trifolium* species (*T. Thalii*, *T. nivale*) were found from the lowest to the uppermost limit, while others (*T. alpinum*) seem to be localized in an area extending from an altitude of 2,000 m. to 2,500 m.

The beech wood is characterized by shade, humidity, and a carpet of decaying leaves, which forms an obstacle for sciophilous vegetation, but does not, unless it exceeds a certain depth, exclude the growth of legumes.

The larch wood presents favourable ecological conditions for the growth of legumes, but the fir wood is characterized by an absolute lack of legumes, the existence of which is impeded not so much by the humidity and shade as by the carpet of leaves which creates a persistent, markedly acid humus in which legumes cannot thrive. The beech wood and larch wood clearings and the alpine pasture zones present favourable conditions for the growth of legumes.

No relation between nodules and root development exists: on a parity of root

volume the nodules are more abundant in the clearings in clay or schist soils. In the clearings, on account of the peculiar environmental conditions, root development is considerable and the number of nodules is likewise great.

Lotus corniculatus has root nodule organisms of bacillary form; all the other legumes collected have nodules of bacterial form. Bacillary and bacterial form have the same functional behaviour; both have the capacity for fixing atmospheric nitrogen.

In the nodule, beyond the nodule organism properly speaking there may exist other forms of organism, such as for example an elongated "gram-negative" bacillum (more numerous in the nodules of the undergrowth legumes than in those of the clearings), fairly widely distributed and to which no reactions have been observed in the host plant. Such organisms are present unchanged in the cultures.

The medium used for cultures of nodule organisms must have neutral or slightly alkaline reaction. The organisms do not develop in acid soil. In culture the organisms from all the legumes assume bacillary form.

In all the legumes studied ectotrophic mycorrhiza prevailed with hyphae of Phycomycete type, only in the legumes growing in the clearings in clay soil was the endophyte of *Rhizoctonia* type observed, always accompanied by the Phycomycete.

The maximum mycorrhiza development is observed in the roots of the legumes in the woodland undergrowth. In the clearings and alpine pasture the mycorrhiza are less developed, but on the other hand the nodules are more abundant.

The nodule organisms (especially in the clearings) and the mycorrhiza (especially in the woodland) create conditions of life favourable to the legumes.

In all the numerous observations made it was constantly observed that the mycorrhiza cease to exist in contact with nodules, either in portions of the roots or in the immediate vicinity of the nodule.

There exists thus a reaction localized in the nodule and in its immediate vicinity which impedes the hypha from coming into contact with the organism.

The nucleus of the cell containing mycorrhiza hyphae presents no perceptible morphological reactions to the systems of fixation and coloration adopted.

MANUAL OF PLANT BREEDING*

Up to the time of reviewing (March 1st, 1940) thirteen parts, each of eighty pages, have been received. Parts 5 to 13 contain, among other material, the following: contributions by J. Hackbarth and H. J. Troll (Müncheberg) on lupins as grain and forage crops and as oil plants respectively (Vol. 3. pp. 32-64 and Vol. 4. pp. 198-206); H. Heyn (Rosenhof, Baden) and W. Hertzsch (Klein Blumenau, East Prussia), an article on the breeding of *Pisum sativum* and *P. arvense* (Vol. 3. pp. 1-32); Lene Herb-Mueller (Bucharest), *Glycine hispida* Max. (Vol. 4. pp. 176-97); A. Tavčar (Zagreb, Yugo-Slavia) and R. Lieber (Rastatt, Baden), *Zea Mays* (Vol. 2, pp. 75-129); and the completion of W. Rudorf's contribution on selection (Vol. 1. pp. 199-253) and of F. Schneider's contribution from Kleinwanzleben on the breeding of *Beta* (Vol. 4. pp. 1-95). [See also *Herb. Rev.* 7. 36-7. 1939.]

*Roemer, T., and Rudorf, W. **Handbuch der Pflanzenzüchtung.** [Manual of plant breeding.] Berlin: Paul Parey. 1938 onwards. RM. 6.50 per part of eighty pages. [Univ. Halle (T.R.), and Kaiser Wilhelm-Inst. f. Züchtungsforschung, Müncheberg, Mark (W.R.), Germany.]

PLANT ECOLOGY OF ZULULAND

[Reviewer: M. HALL]

SINCE the publication of an account of the Dukuduku Forest Reserve and adjoining areas (Henkel and others, *Herb. Abstr.* 6. 328. 1936), knowledge of Zululand vegetation has been extended (Bayer, A. W. An account of the plant ecology of the coastbelt and midlands of Zululand. *Ann. Natal Mus.* 8. 371-454. 1938). Four plant formations are distinguishable in the coastbelt and midlands of Zululand, namely (a) the Coast Forest Formation, (b) the Deciduous Tall Tree Savanna, (c) the Deciduous Short Tree Savanna, and (d) Grassland Formation. (See also Pole-Evans, *Herb. Abstr.* 7. 149. 1937.)

Coastbelt Vegetation

This includes six types of communities among which is the Coast Grassland. Stable grassland does not occur on the coastbelt because of liability to invasion by various types of tree veld and by forest. Grass as the chief undergrowth of tree veld is fired in order to provide fresh grazing for stock. Such fires are a regular annual feature of all grassland and tree veld. On the sandy soils of the coastbelt the initial stages of grassland succession are characterized by creeping, stoloniferous and tufted species. Among the most important pioneers are species of *Imperata, Dactyloctenium, Cynodon, Trichoneura, Digitaria, Tricholaena, Aristida* and *Eragrostis*. *Imperata cylindrica* soon becomes dominant and consocies of this grass occur. The consocies are not stable, however, and give way to the *Themeda triandra—Hyparrhenia hirta* grassland climax. Other important grasses forming societies in the climax include species of *Chloris, Amphilopis, Trachypogon, Panicum*, etc. These are mostly tall-growing and occur near the edges of forest, thus representing a stage at which grassland is easily invaded by forest. Forbs associated with the climax grassland are numerous and correspond to those listed by Bews for Natal (*Ann. Natal Mus.* 4. Pt. 2. 1920).

Midland Vegetation

Three plant formations are recognized, the Grassland Formation, which occupies the plateaux above 20,000 ft., and two Savanna Formations occupying river valleys below 2,000 ft.

The Midland stable or climax grassland occurs only on the comparatively narrow ridges or plateaux between the great river valleys. Grass extends throughout the valleys as undergrowth of tree savannah and provides the chief grazing for stock and game. The ecology of this midland grassland is in general the same as that of the coastbelt, but owing to the more compact soils of the midlands, tufted species are more prominent than creeping or stoloniferous species in the initial stages. All preliminary stages in grassland development are more prolonged in the midlands than in the coastbelt and this fact is attributed to the more xeric conditions of the midlands. For the same reason, and partly owing to the more rugged topography, the effects of grass fires and of overgrazing are more pronounced in the midlands. The best grazing is afforded when the grassland is at the *Themeda-Hyparrhenia* stage. The general effect of burning or overgrazing is to throw back the succession and to reproduce the comparatively non-nutritious *Eragrostis-Sporobolus* stage. In Zululand, areas which are unsuitable for stock farming, because of the presence of the tsetse fly, carry *Themeda*, and the increasing extent of *Eragrostis-Sporobolus* grassland in farming areas is an indication of mismanagement of natural grassland.

Among the postclimax communities of more elevated moist regions is the post-

climax grassland. On south-eastern slopes, taller grasses (4 to 6 ft.) such as *Panicum* spp., *Miscanthidium capense* and *Cymbopogon* spp., are conspicuous, often associated with shrubs. The society is readily invaded by various tree-veld communities described.

Biotic influences

The effects of game animals of many kinds, including elephants, rhinoceros, hippopotamus and numerous species of antelopes are discussed. Wildebeest are the most plentiful antelopes and their effects are much the same as those produced by cattle. Tracks are trampled on hillsides down to drinking pools and the result is to increase soil erosion. The phenomena of veld destruction and soil erosion caused by grazing animals have long been a feature of the country and have only been accentuated since the advent of man and his flocks.

The activities of a leaf-cutting termite in the Hluhluwe River valley is noted. The termite destroys the culms of *Themeda triandra* var. *trachyspathea* and areas of about one-third acre have been thus depleted.

Throughout Eastern Africa all grass vegetation is subject to fairly regular annual fires. During the dry winter the natural grasses die back and become unpalatable for grazing animals. Burning in late summer or in autumn stimulates the grasses to produce fresh leaves, which provide grazing during the first part of winter. Burning in winter is also adopted in order to remove the accumulation of dead leaves, and thus obtain grazing from the new growth as soon as spring activity commences. The custom of grass firing was probably begun in order to provide grazing which attracted game animals, and was continued to provide better grazing for domestic stock. There is little doubt that the practice has been going on for hundreds of years. The role of grass fires in preventing the extension of forests is discussed.

GRASSLAND, SAVANNAH AND BUSH OF THE MORE ARID PARTS OF AFRICA

[Reviewer: G. M. Roseveare]

Professor Heinrich Walter, of the Botanical Institute, Technical College, Stuttgart, has published in *J. wiss. Bot.* (87. 750-860. 1939) a study of "Grassland, savannah and bush of the more arid parts of Africa in their relation to ecological conditions". The opportunity of making this study was afforded in 1937 by a visit to the Laboratory of the Veld Reserve at Fauresmith, Orange Free State, where the author had the co-operation and support of the Director, Dr. Marguerite Henrici. He was also able to visit practically the whole of South West Africa. Fauresmith is situated exactly on the border of the extensive grasslands of the north and the karroo vegetation, with dwarf scrub dominant, of the south. In South West Africa all transitional forms of plant cover are found, from desert vegetation through grassland and different savannah or bush types to the dry forest of the north-east. The subject arose out of previous work by Prof. Walter on "Is the prairie by nature devoid of trees?" (*Geogr. Z.* 41. 16 *et seq.* 1935), from which there may be quoted the footnote to p. 24: "A loose, savannah-like tree stand will not be able to last in the prairie region, because the tree seedlings cannot come up against the competition of the close grass swards. Why they are able to do so in the ropical savannahs, on the other hand, should be more closely investigated."

The study is divided into sections under the following heads. (1) General climatic conditions governing the dominance of grassland. This section is illustrated by a map showing the distribution over Africa of winter rains, summer rains, two rainy seasons, etc. (2) Rooting and root systems. (3) Distribution of grassland and bush in arid regions in its dependence on edaphic conditions. Grassland is found in deep-bottomed soils only, although it avoids the heavy clay soils liable to become brackish in arid regions. The great proportion of grassland in the American prairies and the south Russian steppes is attributable not only to favourable climatic conditions, but also to the presence of wide areas of deep-bottomed soil on diluvial deposits. Conditions in the arid parts of Africa are contrasted. (4) The ecological behaviour of the grasses during the dry season. They do not dry up completely, but the youngest leaves around the growing point remain fresh. Their water content amounts to as much as 90 per cent and over of the dry weight, and their hydrature is scarcely reduced. In consequence even in grasses that look completely dead and brown a certain minimal transpiration can be determined. This is, however, so active that an uptake of water from the soil through the root system is necessary during the dry season, and calculations show that the quantities of water remaining in the soil are sufficient to cover these transpiration losses in normal dry seasons. (5) The ecology of the sclerophyllous plants in South Africa (Orange Free State). (6, 7 and 8) The ecology of the dwarf shrubs and herbaceous plants, of the succulents, and of the poikilohydrous ferns respectively during the dry season. (9) General observations on transpiration in the plants of dry regions. In order to obtain a clear conception of the water balance of plants, and to form a judgment of whether the water output in relation to the local amount of precipitation is to be considered large or small, it is necessary to calculate the transpiration of the plant cover per unit ground area, for it is to the latter that precipitation is related (1 mm. precipitation = 1 litre per square metre). In connexion herewith reference is made to some figures obtained by Henrici and to her findings concerning the tendency of S. African grasses to squander water, the average summer daily output of water being 7 to 8 lbs. per 1 lb. green grass leaves, although daily water outputs of 10 lbs. per 1 lb. leaves are common (see Henrici. *Herb. Abstr.* 9. Abs. 140. 1939). (10) The grassland-bush transition types. (11) The parkland types. (12) The nomenclature of the steppes and savannahs. The use of the term " steppe " is misleading for African conditions and " savannah " should be substituted, indicating grassland in which wood plants play an important part. (13) The productivity of the vegetation in its dependence on the quantity of precipitation. The productivity (the quantity of dry matter formed annually per hectare) of grasslands of different parts of South West Africa was determined, and found to be approximately proportional to the amount of precipitation. It may be said that to every 100 mm. precipitation approximately 1,000 kg. dry matter per hectare are produced.

TOUR OF DR. W. C. LOWDERMILK

According to *Science* of December 29, 1939, Dr. W. C. Lowdermilk, assistant chief of the Soil Conservation Service, has returned to the United States from an extended survey of the experience of older countries in the use of land as it relates to soil erosion, soil and water conservation and torrential flood control. The countries visited included Great Britain, Holland, France, Italy, Algeria, Tunisia, Libya, Egypt, Palestine, Trans-Jordan, Syria, Iraq and Lebanon. The completion of the

tour, through Turkey, Bulgaria, southern Germany and Switzerland, was interrupted owing to the outbreak of war. The survey was made in overland travel by automobile covering nearly 27,000 miles.

"Of special interest to American agriculture are evidences of an advanced degree of refinement in measures to control and conserve storm waters and to control erosion of a productive agriculture during the Roman epoch 2,000 years ago in Northern Africa and in ancient Syria. After the destruction of the Roman civilization and the traditions of agriculture by conquering nomad peoples, former measures of water and erosion control fell into disuse and were broken down. Soil erosion then began its damaging work and throughout this area has generally washed off soils from the slopes, sorting erosional debris and carrying the finer fractions out to the sea and spreading the coarser fractions over old alluvium on the valley floors. This in short is the predominant process at work in the old lands south and east of the Mediterranean Sea, except in the broad alluvial plains of the Nile and Mesopotamia. Agricultural possibilities of to-day are restricted principally to the alluvium of lodged soils in the valley floors and outwash plains and in the improved management of vast grazing areas, where drought and famine have been the chief controls. It is possible to re-forest the hill and mountain lands in Algeria, in Palestine and Syria, particularly where the country rock is limestone and to restore or to improve the productivity and prosperity of these wasted areas.

Dr. Lowdermilk is describing his experiences in a special series of articles to *Soil Conservation*, Vol. 5. Nos. 4, 5, 6 and 7, 1939-40. The series is entitled "Erosion-control lessons from Old-World experience" and the first four articles in the series are:

1. Strip-cropping by inheritance in France.
2. Fish ponds and fields in rotation.
3. Erosion at its worst, and a hundred dead cities.
4. Precedents in the control of water.

The second article describes a unique method of land use found in many parts of France. The third article is chiefly concerned with Syria and adjoining countries, the fourth with land drainage and the work of the Catchment Boards in Great Britain. (See also reference to Palestine and the Mediterranean in *Science*. 91. No. 2352. Suppl. p. 6. 1940.)

JOINT COMMITTEE ON PASTURE IMPROVEMENT, U.S.A.

[Reviewer: R. O. Whyte]

The Report of the Joint Committee on Pasture Improvement is given in *J. Amer. Soc. Agron.* 31. No. 12. pp. 1060-2. 1939. The Committee has been concerned primarily with the inter-Society organization and the development of a procedure for continuing the joint work on the comparative nutritive value and relative cost of forage and other crops.

The former Chairman of the Committee, P. V. Cardon, had succeeded in bringing about the organization of an inter-Society Committee with representatives from the American Society of Animal Production, American Dairy Science Association, Canadian Committee on Pasture and Hay, and the American Society of Agronomy (see *Herb. Rev.* 7. 24-26. 1939.)

The following paragraphs are quoted from the report of the Committee in *J. Amer. Soc. Agron.* 31. 1060-2. 1939.

" A Grassland Conference was held in conjunction with the joint summer meetings of the North-eastern and Corn Belt Sections of the Society at Wooster, Ohio. In addition to a number of other topics of interest to specialists concerned with grassland management and improvement, there was a discussion of ' methods for evaluating pastures in relation to each other and to other harvested feed crops.' A report on the conference was prepared, mimeographed and distributed to those in attendance at the meeting, and others interested in pasture improvement. A resolution was passed to the effect ' that future conferences be held, and that reports of the discussions be forwarded to Experiment Station Directors and all other interested individuals.' The following extract from the report of the ' Grassland Conference ' indicates the nature of the discussion on the comparative nutritive value of forage and other crops :

" Pasture improvement based on findings of Experiment Station workers and others has not found as wide a reception among farmers as the condition of millions of acres of pasture land would appear to warrant. This is believed to be due in large part to the scarcity of information relative to (1) the value of pasture crops in relation to each other, and (2) the value of pasture crops in relation to other harvested feed crops when grown under similar soil and cultural conditions. At present thirteen different methods are used in evaluating pastures and improved pasture practices. There is need for a standardization of methodology. Any method of evaluation should be based on live stock and live-stock products produced and must consider maintenance, production, gains or losses in live weight and supplementary feed required.

" It was suggested that the feeding value of different pasture crops be determined by (1) grazing on comparatively small replicated areas under field conditions, (2) feeding the harvested green forage under standardized controlled conditions, (3) feeding the harvested forage as hay, and (4) feed the harvested forage as silage."

Another grassland meeting was held at the Great Basin Branch Station of the Intermountain Forest and Range Experiment Station, Ephraim, Utah. A report on the meeting was made by the U.S. Forest Service, under the title "Proceedings of the Range Research Seminar, July, 10-22, 1939." Special consideration was given to nutritional problems. The following extract indicates the nature of the discussion :

" The necessity for detailed information on nutritional problems of range livestock is becoming more and more evident as range management progresses. The utilization standards studies in particular have shown the need for more definite information on nutritional values of range forage plants through the season and in relation to different degrees of use. Animal nutrition studies have been the subject of experimentation for a great many years by State Agricultural Experiment Stations.

" Most of the effort of these institutions, however, has been expended on animal nutrition studies under feed lot rather than range conditions. Before the Agricultural Experiment Stations can expand their programme of research to include nutritional studies of range plants and animals, additional funds, equipment and personnel will be needed. The degree of participation by the Forest Service should depend largely on the adequacy of coverage within the field of endeavour ; that is, if the State institutions satisfactorily provide the needed information on nutritional phases, participation then should be restricted to co-operative assistance.

" The tentative programme of western-wide determination of chemical analyses of range plants prepared in 1938 by the Bureau of Animal Industry and the Forest Service represents a beginning in the interpretation of range nutritional problems. As a basis for preparation of further programmes of this nature your committee desires to list some of the specific nutritional problems of range livestock and range plants

that need investigation: (1) Forage requirements of the grazing animal; (2) Nutritional values of range forage plants in relation to degree, season, kind of use, past treatment, and soils; (3) Relation of nutritional values of various vegetation types to forage acre requirements and to the growth, maintenance and production of grazing animals; (4) How to handle areas of seasonably palatable forage on a year-long basis; (5) Effects of different methods of handling on the nutrition of range animals; (6) Effect of elapsed time, including weathering, on nutritional values of range forage plants, and (7) Nutritional values of the principal range forage species by actual feedings tests.

"It is evident from the several conferences held to date that the desired progress on this important topic cannot be made satisfactorily until the necessary assistance is made available to (1) compile available information as an aid in the formulation of experimental work for distribution to investigators interested and in a position to give consideration to studies of relative values of pasture, forage, and other crops; and (2) the development of a carefully conceived investigational procedure for consideration by agronomists and animal specialists interested in pasture research. Funds are being sought for this purpose."

The report is signed by J. Abbott, B. A. Brown, P. V. Cardon, D. R. Dodd, C. R. Enlow, R. D. Lewis, O. McConkey, G. Stewart, P. Tabor and O. S. Aamodt (Chairman).

DOMINION EXPERIMENTAL FARMS, CANADA*

Division of Forage Plants

The activities of the Division of Forage Plants consist of the testing of grasses, leguminous crops and hoed crops to determine their productiveness and suitability for use in Canada; the selection and breeding of grasses, legumes, corn, field roots and sunflowers; the study of hay and pasture problems; the production of seed and its distribution; special research activities such as plant introduction, plant nutrition, and cytology.

Variety tests

Extensive tests are carried on to determine the varieties of grasses, clovers, alfalfa, corn, soybeans, sunflowers, field roots and other forage plants that are best suited to the different agricultural zones of Canada. These tests include not only the old established varieties but also new varieties and selections, so that information may be available at all times for the guidance of the Canadian farmer as to what types and varieties of forage plants are most suitable and productive in any particular zone.

In this connexion it is interesting to note the results of two projects having direct application for practical use. Variety tests of swede turnips have resulted in the introduction from Europe of the club-root resistant variety, Wilhelmsburger, which is being rapidly multiplied and distributed by the Dominion Experimental Farms in the Maritime Provinces. In varietal tests of clovers and alfalfas it has been conclusively proved that the material from some sources was not suitable for use in Canada, owing to lack of winter hardiness. Based upon actual results of growing tests, legislation is being enforced, making it possible for the Canadian farmer readily

*Sections reprinted from the publication of the Ministry of Agriculture, Ottawa, The Dominion Experimental Farms, Ottawa, 1939. pp. 47.

to distinguish between suitable and unsuitable clover and alfalfa seed and so reduce to a minimum the chance of loss of crop through winter-killing.

Breeding and selection

An extensive programme of grass breeding has as its object the production of improved strains for hay, pasture and turf purposes. The species with which work is carried on are timothy, orchard grass, brome grass, perennial ryegrass, bluegrasses, the fescues, bent grasses and millets. A number of improved varieties, including Boon timothy, Parkland brome grass, Grazier western ryegrass, Crown and Empire millets have been developed as the result of this work and have been made available for general distribution. The possibility of developing a large seeded, vigorous growing, drought resistant perennial grass, through crossing various species of grasses (*Agropyron*) with common wheat, is being investigated. Such a grass, if obtained, should be of inestimable value to the dry areas of the West.

Breeding work is also in progress with the legume crops, including alfalfa, red clover, sweet clover and white clover. Improved strains of alfalfa have been developed, including a new self-tripping strain for high seed production. A hardy, productive, early red clover variety named Ottawa has been selected and established in the Ottawa valley. White clover strains are receiving special attention in connexion with pasture investigations. Two lines of coumarin-free white blossom sweet clover have been isolated, and two annual early flowering strains of sweet clover, especially promising for bee pastures, have been developed and distributed for trial. Work in connexion with soybeans has resulted in the selection of two early maturing varieties, Mandarin (Ottawa) and Kabott, and seed of both has been multiplied and widely distributed in recent years. Kabott is ten days earlier in maturity than Mandarin and makes possible the growing of soybeans over a more extensive area in Canada than formerly. More recent selections have been developed which are still earlier than Kabott, and seed of these is being increased and made available as rapidly as possible.

Hundreds of selfed lines of field corn have been isolated by inbreeding in recent years. The best of these have been combined by crossing, with the object of producing either new varieties or vigorous hybrids to meet the various needs of the wide range of the Canadian climate. Breeding work with mangels and swedes has resulted in the production of two improved varieties, the Tip-top mangel and Acadia swede turnip. Seed of both varieties has been made available for distribution. The possibility of developing varieties of sunflowers possessing seed of high oil content is being investigated.

Hay and pastures

Special attention is being given to hay and pasture problems. Pasture improvement constitutes one of the major problems in Canadian agriculture. Particular attention is directed to the study of pure species and mixtures of grasses and legumes, their productivity, palatability, nutritive value, aggressiveness, persistence under grazing, and reaction to fertilizer treatments. Annual and supplementary pastures are being compared for midsummer use when the permanent pastures are at their lowest level of production.

Seed production and distribution

This phase of work includes the study of seed production methods, the multiplication of new varieties and strains, and the distribution of this seed to farmers through the services provided for the purpose. In recent years, the following productions of this division have been accepted for registration by the Canadian Seed Growers'

Association : " Ottawa " red clover ; " Acadia " swede turnip ; " Tip-top " mangel; " Mandarin " (Ottawa) and " Kabott " soybeans ; " Parkland " brome grass ; " Crown " and " Empire " millet.

Special research activities

New species and varieties of forage crops are continually being introduced from all parts of the world and tested in an introduction nursery, where their promise either for direct use or for use as breeding material is ascertained. Plant nutritional studies are conducted in the greenhouse during the winter months, the plants being grown under controlled conditions, using nutrient solutions. These studies make it possible to determine suitability of certain varieties to particular types of soil, and to associate malnutrition symptoms with the special mineral deficiency under field conditions. In the field of cytology, studies are being made on certain species where fundamental information is required prior to hybridization work.

In addition to the work outlined, the division has perfected a cheap, quick, accurate system of dry matter determination for the purpose of reporting forage crop yields. Experiments are conducted with turf grasses, and information is made available on the various grasses adapted to the different types of lawns. Educational exhibits are frequently prepared, and farmers are given assistance on all phases of forage plant work by means of circulars, bulletins and private correspondence.

Field Husbandry Division

To secure reliable information on the most profitable methods of field crop production under various climatic, soil and marketing conditions, the Field Husbandry Division conducts extensive investigations into cropping, cultural, fertilizing, and farm management practices on the different Dominion Experimental Farms throughout Canada. Through the results of these investigations farmers are able to learn what practices are likely to prove the most profitable on their farms, as well as those which should be avoided.

Rotations

The results of rotation experiments conducted over a long period of years throughout Eastern Canada indicate that the best sequence of crops is that which combines the most effective weed control with the greatest economy of tillage operations and which adapts itself to the desired type of farming. Under the semi-arid climate prevailing in the Prairie Provinces, which limits crop production largely to drought-resistant grains and grasses, rotation practices are centred round the summer-fallow. The essential practice of summer-fallowing for soil moisture conservation was introduced into Western Canada through the Dominion Experimental Farm at Indian Head, Sask., and subsequent experiments have demonstrated the value of this practice for weed control.

Drought and soil drifting in Western Canada

In connexion with the important problems of drought and soil drifting in the Prairie Provinces, a considerable amount of experimental work is in progress on Dominion Experimental Farms, District Experiment Sub-stations and Reclamation Projects. The adverse effects of drought are offset to some extent by suitable rotations and by summer-fallow practices which result in the maximum conservation of soil moisture. Soil drifting has been successfully controlled in many districts by the practice of strip farming and the adoption of improved methods of surface cultivation.

Weed eradication

The loss to Canadian farmers which may be credited to weeds is impossible to estimate, but must amount annually to approximately 70 millions of dollars. To learn the most effective and least expensive methods of weed eradication, many experiments are in progress.

Successful eradication of annual weeds, which reproduce by seeds alone, depends largely on preventing the formation of seed which would re-infest the soil. The thorough cultivation and hoeing of row crops and the judicious harrowing of young grain crops are effective cultural methods of weed control. Seeding grain at somewhat higher than normal rates has resulted in some reduction in weed growth by competition. Spraying with a three per cent solution of copper sulphate will completely kill mustard growing in grain with no appreciable injury to the crop. Chemical dusts also offer a very promising method of weed control.

The control of perennial weeds which reproduce from both seeds and rootstalks has been extensively studied. After-harvest cultivation is probably the most effective method of eradicating these weeds. Growing intertilled crops for two years in succession has also proved beneficial. Spraying small areas with chlorate sprays will kill most perennial weeds. This method, however, is too costly for large areas.

An important source of weed infestation is manure containing weed seed. Experiments have shown that rotting manure from one to three months, depending on the season, will destroy all weed seeds excepting those on the surface of the pile.

Harvesting experiments

Proper harvesting methods are essential in ensuring good quality farm crops. Extensive experiments have been carried on over a long period of years to determine the best and most economical methods of harvesting and storing hay crops and of harvesting grain and silage crops with different types of machinery. Crops successfully ensiled at Ottawa include corn, sunflowers, alfalfa, red clover, alsike, timothy, barley, buckwheat, millet, soybeans, Jerusalem artichoke, and a mixture of oats, peas and vetches. Some of these crops, notably alfalfa, require great care for successful ensiling. Crops which did not make good silage were hemp, kale, mangels, turnips and potatoes. Preservation of ensiled crops by acid treatment, and the improvement of high protein silage by the addition of molasses, have proved quite feasible although at a somewhat increased cost.

Pasture and range studies

In Eastern Canada there are over 12,000,000 acres of pasture, of which nearly 6,000,000 acres are on unimproved land. The best utilization of permanent pasture land requires careful management to ensure the correct intensity of grazing, the removal of coarse, unpalatable herbage, the suppression of brush and weeds, and the provision of supplementary feed at certain periods of the season Rotative grazing of pasture land has resulted in some increase in carrying capacity, but this gain is offset by the cost of constructing additional fences and watering facilities. The judicious application of fertilizers has produced economical increases in the growth of herbage on many pastures. On pastures which can be ploughed and seeded to cultivated grazing crops, decided increases in production over native pasture herbage may be secured in many regions.

The improvement of grazing conditions on some 36,000,000 acres of range land in Western Canada is the object of large scale experimental work on the Dominion Range Experiment Station at Manyberries, Alta., and at Kamloops, B.C.

SCANDINAVIAN LITERATURE

MEADOW PLANT DAY AT SVALÖF

[Reviewer: R. Peter Jones]

In view of the many problems which have emerged recently in connexion with the new methods of conserving meadow plant products, the Swedish Seed Association invited persons interested in these questions to a conference at Svalöf on June 13th, 1939. The object of the conference was by means of introductory speeches and demonstrations to elucidate the various questions, but possibly above all to bring together experts in the different spheres for free discussion. As these matters are also closely connected with questions regarding variety, the Seed Association considered it to be of great importance, firstly, that breeders of meadow plants should procure an opportunity of having the questions elucidated from all sides, and secondly, that they should state their own points of view and have them examined critically.

Professor Å. Åkerman, in his address dealing with the extent of ley cultivation and its importance for Swedish agriculture, stated:

"Ley cultivation is, as is generally known, very extensive in Sweden, and the profitableness of our crop cultivation depends in a high degree on the yield of the leys and also on the economic gain from the products obtained from the leys: hay, green fodder and pasture. Of the country's whole arable area, in round figures 3.7 million hectares, about 1,380,000 hectares, or 37 per cent, consist of hay leys. In addition there are 160,000 hectares of cultivated pasture. Thus together 1,540,000 hectares, or slightly more than 40 per cent, of our arable area are used for ley cultivation. In addition we have approximately 100,000 hectares of so-called cultivated grazing meadows, 400,000 hectares of hay meadows and lastly 600,000 hectares which in statistics are designated as 'other grazing meadows'.

"A still better idea of the great importance of ley cultivation is obtained if the harvested yield from the leys is investigated. The yield of hay and pasture alone from the hay leys has been computed at 3.1 million food units with 390,000 tons of digestible protein. For comparison it may be stated that our import of concentrated fodder and oil cake amounts to only about 300,000 million food units or to approximately one-tenth of the hay crop. Further, it may be pointed out that our total indigenous fodder production—what is considered will be used as human food excepted—amounts to 7.3 milliard food units with 730,000 tons of digestible protein. It is thus clear that the yield from our ley areas of different kinds is of very great, indeed of vital, importance for the support of our people, and that the higher yield we can attain on them the greater possibility we have of providing the population of the country with butter and meat, not to mention other animal products Even under normal conditions the yield of the leys if of course of the greatest significance and in an essential degree decisive for the profitableness and competitive ability of Swedish agriculture. It is therefore of the greatest importance that ley cultiva-

Vallväxtdagen i Svalöf den 13 juni 1939. Å. Åkerman, G. Nilsson-Leissner and F. Nilsson. [Meadow plant day at Svalöf, June 13, 1939.] Sveriges Utsädesförenings Tidskrift 49. 351-63. 1939.

tion should be made as remunerative as possible. Here, however, it is a matter not merely of raising the harvested yield by means of better varieties and more rational manuring, but it is also an important question how that part of the ley yield which cannot be utilized directly as pasture or green fodder can be turned to account in the most economic way. The usual way of making hay is unfortunately a very uneconomic method of conservation attended by substantial losses of dry matter. On the average approximately one-third of the dry matter present in the green mass is lost when hay is cured in the usual way, to which is added a not inconsiderable reduction of the content of certain vitamins, in the first place A, B and C.

"On account of the considerable losses in nutritive value associated with the usual method of hay making an endeavour has been made to proceed along different lines in order to preserve the ley yields, and in particular two methods have been employed, namely the preparation of A.I.V. fodder and artificial drying. With both these methods the losses are considerably less than with ordinary hay making, a circumstance which will be dealt with more fully in the addresses which follow.

"The Swedish Seed Association has considered it desirable that the value of these methods should be explained by practical men on this meadow plant day."

Addresses on experiences in the preparation of A.I.V. silage and on artificial drying of hay followed.

Dr. Nilsson-Leissner, in an address on the resistance of white clover to drought and on ley mixtures of different types of earliness, spoke as follows:

"When about a month ago we fixed the date of this meeting we hoped it would be possible to show fine meadow plant trials to those present. That this, however, has not been the case is due above all to the continuous drought which has prevailed for a long time in the district. As regards the trials with one-year leys it might perhaps be added that the nurse crop last year was slightly too dense and luxuriant and therefore hampered the meadow plants sown in it. Lucerne (*Medicago sativa*) in particular suffered. As to the pasture plants, which come within my special province, there is not much which can be demonstrated now. The first cut has already been taken and as subsequently there has been practically no aftergrowth, only burnt plots are to be seen instead of the green and dense stand we had hoped for. White clover (*Trifolium repens*), however, constitutes an exception. As all those present have themselves this year had experiences similar to ours and therefore understand that our unsatisfactory trials are due to the weather and not to mismanagement, we venture to ask you to visit the experimental grounds. In spite of everything, there are some interesting things to be seen there.

"The plant species among the pasture plants which usually suffers most from prolonged drought is, as is known, white clover. As it is in addition decidedly the most important species of legume for our pastures it seemed to me to be one of the most important aims of plant breeding to seek to produce strains of white clover which are resistant to drought. Through observations on the experimental grounds during periods of drought, it was easy to determine that differences in this respect are found between different lines in the breeding material. In experiments conducted in the greenhouse it has been possible to confirm this. It was interesting to find that foreign strains of white clover from regions with a drier climate proved superior in these experiments to the majority of Swedish, Danish and English strains, which come from regions where the climate is relatively damp.

"The question was to find out the causes of the varying resistance to drought. Many can be conceived of, but I shall here deal with one only, which we have recently studied closely at Svalöf, namely, the depth to which the roots generally penetrate into the soil. Different strains have in this respect shown very characteristic and statistically certain differences both in average root length and percentage roots which penetrate to a depth of more than 15 and more than 20 cm. Large-leaved

forms with long petiole and peduncle, which thus grow high above the surface of the ground, are found as a rule to penetrate comparatively deeply below the ground. This can be said to be almost a necessity for the plant, as evaporation in this type is undoubtedly greater than in those forms which have short petioles and peduncles and small, compactly arranged leaves. If one divides the white clover material into these two types and afterwards within these investigates the connection between drought resistance and root depth, one obtains a very good parallelism. As the first of the visible results in our effort to obtain white clover strains with a greater power of resistance to drought, the Seed Company this year placed on the market Hero white clover, which in yield trials generally speaking was on an equality with Morsö, but in six different cuts immediately after a period of drought was on the average superior to that variety in yield of green mass by 17 per cent.

" In connexion with the addresses to be delivered today, concerning the preparation of A.I.V. fodder and artificial drying, I would particularly wish to make a few remarks from the plant breeding point of view. With both methods of conservation, only when first class material in the most suitable stage of development is used can they have a prospect of being remunerative. As on the other hand by means of these methods one becomes more independent of the weather, but at the same time from the points of view of economy and distribution of labour should preferably be able to work continuously during the greater part of the growing period, it is necessary during the whole summer to have some ley type in a suitable stage of development for cutting. If this is to be done, it is necessary to have a whole series of leys of different types of earliness and aftergrowth capacity. Both pasture- and ordinary hay leys should be used, and, wherever that species does well, lucerne which is high yielding, rich in protein, drought resistant and makes rapid aftergrowth should be grown either in pure plots or in mixtures with grasses of a suitable degree of earliness. For short duration leys Hungarian (Jugoslavian, Bulgarian) lucerne can be recommended, but for all long duration lucerne leys the strains of Grimm now on the market should alone be used. In passing, I would mention that lucerne breeding of the Seed Association has resulted in two very good strains —the one produced at Svalöf, the other at the Ultuna Branch Station—which have now been handed over to the Seed Company and have been distributed for growing in contract plots.

" For inclusion in mixtures with lucerne, various grass species may be mentioned. On dry ground cocksfoot (*Dactylis glomerata*) or *Bromus inermis* are the most suitable while on clay soil both timothy (*Phleum pratense*) and perennial rye-grass (*Lolium perenne*) as well as early meadow fescue (*Festuca pratensis*) can be used with advantage. *Bromus inermis* is also very suitable here. These species do not oust lucerne, which cocksfoot unfortunately has a tendency to do, but which, on the other hand, makes particularly good aftergrowth. In leys specially put down for artificial drying, which are designed to be cut three to four times during the summer, one should for that very reason generally include cocksfoot or *Bromus inermis*. Cocksfoot has for the rest during recent years—rightly—been reduced more and more in our leys, but it is possible that a revival of this species is to be expected, when it will be used for stands to be cut at a very early stage and several times during the summer. The late varieties Skandia II and particularly Brage, with its good aftermathing capacity, can be recommended in such cases.

" Also for ordinary hay leys with red clover (*Trifolium pratense*) one should, for the above-mentioned reason, have seeds mixtures of different degrees of earliness. Unfortunately as regards red clover itself, the early types which are now available are decidedly less persistent than Swedish late clover. For this reason every effort is being made to produce strains of the early type which are more resistant to disease and frost, but it is too soon to express an opinion as to whether this will be successful.

Meanwhile trials extending over many years have shown that if Swedish late clover is cut as early as early clover usually is, the yield of the former as a rule, even in the first year ley, is as good as that of the latter and in addition the quality is better. The aftergrowth is also very good. As Dr. Nilsson in his address will deal with the different strains of clover in detail, I shall not dwell upon them longer.

" Of timothy there are now in our comparative trials besides Svalöf's three standard varieties for south, middle and north Sweden (Gloria, Bore and Bothnia) promising lines of both extremely early and extremely late varieties which, if it should prove to be necessary, can at once be placed on the market. As regards meadow fescue, for a long time two types differing in earliness have been procurable from Svalöf : Svalöf early and Svalöf late, with a difference in earliness of a week to ten days. As to perennial rye-grass, Svalöf Viktoria belongs to the later types, which grow well with lucerne, early or medium-late red clover. A still later type, equal in earliness to middle Swedish late clover, would, however, be of value, and we now have such a type in our breeding material. These types are above all to be used in pasture leys, and also in these we require both later and earlier seeds mixtures.

" During the early part of the summer, when growth is vigorous and rapid, it is, as is known, difficult to arrange for the grazing of all the folds so that none become overgrown. To be sure it is now possible to convert the crop into A.I.V. silage or to dry it artificially where the necessary equipment is available, but there is no doubt that for rational pasture management it is convenient to have both early and slightly later stands in different folds. With this in mind, two varieties of smooth-stalked meadow grass from Svalöf which differ in earliness have been placed on the market : they are Skandia I and II of approximately the same earliness as ordinary American commercial seed and Fylking, which is about a week later. Viktoria rye-grass is suitable for including in a mixture with the former variety, while with Fylking a slightly later type can be used, such as I mentioned earlier. In white clover too we find such differences in earliness. Morsö white clover and Hero can be said to belong to those earlier in the spring, while Svea and some promising lines from English wild white clover of which we expect great things are later, at least as far as flowering is concerned.

" Reference should also be made in this connexion to some new species of plants which will soon be more generally tested in Sweden. Of legumes, I will only mention sweet lupin for sandy soils and the *Melilotus* species (white and yellow melilot), which are only biennial, very modest in their requirements and particularly rapid in growth. Among the grasses I have already mentioned *Bromus inermis*, which undoubtedly should be more widely distributed, especially in drier areas. The same applies also to the Siberian relative of *Agropyron repens*, *A. cristatum*, which has become widely distributed in dry places in the U.S.A. Further, a grass species which has an unprecedented production capacity and is perennial and is also suitable for normal or damp conditions is *Phalaris arundinacea*. Harvested at an early stage, this species gives a hay equal in value to that of timothy. We have some small plots of these species on our experimental grounds."

Dr. F. Nilsson then delivered the following address on some current points of view regarding hay ley plants :

" The drought has this year been very severe and has caused a decimation of the hay crop through the poor development which the majority of the meadow plants were able to show. It is obvious that strain trials with meadow plants under such conditions are not so reliable as they can be under more normal conditions. Inequalities unfortunately show up too prominently and the whole points to unreliable results, while at the same time abnormally poor development entails of course less obvious differences between different strains. Naturally there is something to be learnt even from such conditions, and a breeder has therefore no occasion to discard

his trials at once even if the figures do not correspond with normal yields and normal relations between known and unknown strains.

" It is of great immediate interest to know which species are able to resist a period of drought, and if differences in this respect are noticeable among different strains. As is well known, certain meadow plants are less sensitive to drought and are therefore able to grow fairly well even during a period of drought. This is true of all those plants which have a deep root system and which on the drying up of the soil can obtain moisture from deeper earth-layers. Such meadow plants, which in the wild state are to be found on poorer and drier soils, are in this respect better equipped than those which are adapted to damper habitats. Such plants are *Anthyllis vulneraria*, *Lotus corniculatus*, *Melilotus* and *Medicago sativa*, the meadow legumes which are able to grow best on drier soils and are able to develop a deep root system. Among the grasses may be mentioned *Avena elatior*, *Festuca duriuscula*, *F. ovina* and *F. rubra*, together with the *Bromus* species, all of which are found on dry ground and are able to manage better than most other grasses with a relatively small supply of moisture. *Dactylis glomerata* also is among our more drought-resistant grass species, while *Phleum pratense*, *Festuca pratensis* and *Lolium*, appear to have a greater requirement of good soil-moisture to be able to attain satisfactory development with fairly good green mass production.

" In the year's hay plant trials we find the best development in *Medicago sativa* and *Dactylis glomerata*, while *Trifolium pratense* and *Phleum pratense* have suffered and been retarded to a relatively greater extent. During dry years *Medicago sativa* is always highly valued, and the tendency which has been shown recently to increase the admixture of lucerne in the ordinary clover leys in Scania appears to be due in part to this circumstance and in part to experience of the untrustworthiness of the early, so-called Silesian clover. There is no doubt that *M. sativa* on drier soils constitutes the only fairly reliable grassland legume accessible to us, and it may in this connexion be emphasized that *M. sativa* is still not so widely used as it deserves to be on lighter soils, where it is better able than any other plan to convert available inorganic nutrients into valuable organic matter.

" *Dactylis glomerata* has become very general as a hay plant in Scania, while further north it is becoming more and more rare. Cocksfoot is very intolerant of other meadow plants and particularly of clover, which is gradually suppressed, so that leys with an admixture of cocksfoot in time tend to become pure cocksfoot leys. In long-duration leys cocksfoot is therefore directly harmful to the clover stand and is not regarded with favour in long-duration hay leys in middle and north Sweden. In one-year and possibly also in two-year leys in Scania, cocksfoot does not, however, as a rule attain to the same predominating position in the ley stand, but can in a valuable way contribute to an increase of the hay crop. Its aftergrowth is also more luxuriant than that of timothy.

" Of special interest of course is the question how different strains of meadow plant species react to the prevailing drought. There has been experience earlier of a difference in susceptibility, and this year too a certain differentiation in the strain material appears to be evident in this respect. Within the different species it will more generally be possible to determine that earlier strains very frequently manage better than later types, which is due to the fact that the earlier strains have utilized the spring sap better, and have already absorbed large amounts of nutriment before the drought properly asserted itself, and therefore for the greater part provided for their requirement of water for the development of the vegetative parts. Thus it is known that late clover is not so reliable in dry regions, as for example in the Kalmar area, where early red clover gives the best results. The early type manages to attain a fairly satisfactory development before the real period of drought and has possibly also, owing to its smaller mass of leaf, a relatively smaller requirement of

moisture than the leafy late clover. Whether also there are differences in regard to the development of the root system has not yet been investigated and elucidated. To the extent that early clover has overwintered and also escaped attacks of clover stem rot and clover eelworm, it will probably this year give a relatively good yield. To avoid misunderstanding, I will in this connexion emphasize strongly that foreign early clover even in Scania is very uncertain and its cultivation in Sweden is hardly justified. The reason frequently given by farmers for its use, better aftergrowth than in late clover, can no longer be fully maintained, since there has been a growing tendency to change to the medium-late Scanian type of clover and the taking of an earlier cut than was usual previously has been introduced. At Svalöf with early cutting as good aftermath is obtained from the medium-late red clover as from the early foreign red clover. In the more favourable coastal areas of Scania experiences appear, however, to be slightly better than at Svalöf and under comparable cultivation conditions. At so short a distance as between Svalöf and Landskrona, the differences are clearly marked, so that one can easily understand the different opinions which are prevalent regarding this type of clover. The medium-early Swedish types of clover, among which in particular the Wambåsa strain has shown a high cultivation value, can certainly under all conditions take precedence of Silesian clover, although they do not attain exactly the same degree of earliness. As an early, reliable type of red clover is, however, being sought after for one-year leys and particularly for dry areas, we have included the production of such a type among the problems red clover breeding has to solve in the near future. Essi clover has hitherto been tested for only two years in trials at Svalöf, and its cultivation value has therefore not been definitely established. It appears, however, to be as early as Silesian red clover and to give a higher yield than that variety, although it does not seem to be able to compete with Wambåsa in yield.

" The grass species cocksfoot, timothy and possibly in a still higher degree meadow fescue show this year a very much more favourable development of the earliest strains than of the later ones, which have been short and low-yielding. Even with the same degree of earliness in different types, however, differences in resistance to drought can manifest themselves, a fact to which this year special attention should be paid in forming an estimate of the yield figures from the strain trials.

" Regarding drought it must also be emphasized that the harmful effects are always considerably less marked in soils rich in nutriment, so that in fertilizers one has a valuable means of counteracting drought to a certain degree. Especially on clover-deficient leys is it generally, and when drought is feared in particular, ill-advised to be too sparing with stimulating nitrogenous fertilizer.

" As red clover is at present and will also in the future probably be our most important hay ley plant, the yield from our hay leys depends in the first place on whether the red clover grows well, and in the estimation of the stand and harvest yield interest attaches mainly to the clover. A more reliable and more remunerative hay production is therefore most frequently seen in combination with possibilities for cultivation of red clover. Circumstances differ greatly in this respect from Ystad in the south to Haparanda in the north, and the prospects of success are not equally good for red clover cultivation everywhere, but on the majority of mineral soils red clover can be induced to make good growth, and it is often a question of suitable strains adapted to local conditions, whether these are extreme as to soil, severe winters or destructive diseases. The last-mentioned point of view concerns in particular the most southerly districts and especially Scania. Uncertainty in regard to red clover is as great in Scania as farther north and often even greater, due to the devastating diseases which previously were considered to be clover sickness. It is now generally known that the so-called clover sickness consists of injuries caused partly by *Sclerotinia trifoliorum* and partly by *Tylenchus devastatrix*. Diseases

caused by them have been confirmed from Scania and right up to Norrland, but for the present the injuries are much more extensive in the most southerly districts. As where certain diseases of cereals and other cultivated plants are concerned, the question of the possibility of breeding resistant varieties is to be investigated immediately. It is encouraging that it has been possible to determine very clearly differences in susceptibility in the different strains, so that there is a likelihood of the production of new varieties with increased resistance.

" Regarding clover stem rot, it has long been recognized that foreign early clover is more readily attacked and destroyed than Swedish late clover, and within the last-mentioned certain local strains have proved more resistant than others. The Scanian local strains from Karaby, Harrie and Spannarp are thus undoubtedly better than other local strains, evidently due to natural selection which, during the course of the years, has asserted its influence in cultivation under Scanian conditions. It has also been possible to determine certain differences in susceptibility to the clover eelworm. In this respect the Spannarp strain has proved most outstanding among the local strains and has given a relatively better yield when the clover eelworm has ravaged the trial plots. A Danish strain, the so-called Hjelm strain, was reputed to be particularly resistant to the clover eelworm ; it is undoubtedly better than many other strains, though it is not quite equal to the Spannarp strain.

" A particularly good combination of resistance to both clover stem rot and the clover eelworm has been attained in the new Mercury clover, which was bred by Dr. Sylvén at Svalöf and placed on the market two years ago. The old Spannarp strain is the mother variety of Mercury which was obtained through multiplication of a few plants which survived after a very severe clover eelworm attack during the years 1928-30. In regard to resistance it therefore constitutes an improvement on the Spannarp strain which for the rest in earliness and many characters it very closely resembles. To clover stem rot also Mercury clover has shown an exceptional degree of resistance, which surpasses that previously found in other strains. This marked improvement was attained by selection through many generations in cultivation at Svalöf on heavily infected soils. The good power of resistance to the most serious diseases of clover is often very strikingly shown in the trials. Thus Mercury stands at times quite unaffected, when other strains are to a greater or lesser extent destroyed. In the second year ley it is sometimes the only strain which is able to give a fairly satisfactory clover stand, and it must be held up as a particularly important result of Swedish clover breeding, which will be welcomed in many Scanian leys where the diseases mentioned are rife. Mercury clover can also be employed north of Scania and particularly in cases where clover stem rot and the clover eelworm can be proved to be the causes of unsuccessful red clover leys. Other factors, however, restrict the distribution of the strain further north, where strains with the same resistance combined with adaptation to local conditions for the rest must be bred. Mercury is medium-late in development and yields with early cutting a relatively good aftermath.

" Regarding lucerne, I would merely state that positive results from breeding work can soon be reckoned on to prove of use to agriculture. By repeated selection from Hungarian lucerne a strain, Sv 0610, has been produced which has proved so superior to Hungarian lucerne and Grimm lucerne in yield of green mass that it is now considered it should be multiplied on a large scale for use in practical agriculture. By means of orientating seed production trials it has also been possible to show clearly that this strain can set seed in our climate, so that it appears to be possible at any rate to produce stock seed for an eventual production of bulk seed under more favourable climatic conditions elsewhere."

CONFERENCES

Australian and New Zealand Association for the Advancement of Science

The following summary of a discussion on pasture improvement held by Section K (Agriculture and Forestry) of the Association, Canberra, January, 1939, is reprinted in full from the *Australian Journal of Science*, Vol. 1. No. 5. pp. 156-8. 1939. More detailed discussion of certain points raised by the various contributors may be found in *Herb. Publ. Ser. Bull.* No. 29, " Grassland investigations in Australia ", published by the Bureau, January, 1940, price five shillings.

The discussion indicated the main lines on which the scientific development of grasslands should proceed in Australia. Emphasis was laid on the need for classifying grassland areas into clearly defined regions based mainly on climatic and soil characteristics, i.e. the delineation of the edapho-climatic zones ; the determination of the species and strains best adapted for each edapho-climatic zone ; and the development of pasture management methods that would maintain each pasture association at an optimum level of productivity and quality.

The outstanding feature of the pasture association is its complexity and its ever-changing composition caused by the influence of the climatic, edaphic, and biotic factors to which it is continuously exposed.

Climate is a dominating factor in determining the character of the grassland associations and the nature of the pasture growth.

Dr. H. C. Trumble emphasized the paramount importance of the time interval over which growth is not inhibited, together with the conditions of light duration, temperature, and moisture supply over that period. Critical limiting values were provided in the case of moisture by a relationship between monthly rainfall and evaporation designed to operate about the wilting coefficient of a surface soil layer, and in the case of temperature, by mean monthly values indicative of varying growth rates for each of the three winter months. The significance of winter temperature in influencing growth was of importance. Thus at Bunbury (W.A.) growth took place continuously throughout the winter, but at Cooma (N.S.W.) growth was inhibited for the three winter months, despite the favourable soil moisture conditions during that period.

On the basis of the above criteria Dr. Trumble defined ten distinct agro-climatic zones in those agricultural areas of Australia that were dominated by winter rainfall.

Dr. A. McTaggart dealt with the climatic factor from another aspect. By correlating observed successes and failures in exotic plant establishment with the Meyer ratio, he showed that the Meyer ratio isologs indicated in a general way (with a qualification for the soil fertility factor) the degree of " favourability " for the establishment of exotic pasture species. The higher the Meyer ratio, the more favourable the environment for most perennial exotic species.

The major perennial pasture species of temperate Europe could be established in southern latitudes, and the sub-tropical species of Africa and South America in northern latitudes, with Meyer ratio isologs exceeding 150. Establishment of exotics became increasingly difficult as the 75 Meyer ratio isolog was approached, and below this limit only annual pasture species with a short seasonal growth period offered possibilities. Below the 50 isolog the possibilities of plant introduction were exceedingly remote.

Dr. J. R. A. McMillan stressed the outstanding need, in the production of improved strains of pasture plants many of which are naturally cross-pollinated, of obtaining as wide a collection of genotypes or genes as possible from which, by selection, forms suited for specific environments might be obtained. In the ultimate determination of the genotypical value of the strains, the environment in which the testing is to be done must be as nearly identical as possible with that

under which the strain is to be commercially produced. He stressed the need for exploiting as fully as possible the genetic variations induced by hybridization, not only in self-fertilized species but also in species that are naturally cross-fertilized.

Dr. J. G. Davies dealt with the importance of the biotic factors, and their application to grassland management. In so far as control of the environment is practicable, so is improvement feasible. The complex of biotic factors, particularly the intensity and frequency of grazing, are to a considerable degree controllable. The maintenance of any particular combination of herbage species at an optimum level of productivity—having regard to each and every desirable species in the sward—is a matter of extreme difficulty. This difficulty was, however, one of lack of appreciation and of knowledge of the precise reaction of the species as individuals, and of the sward as an entity, to the external factors. A knowledge of the seasonal growth curves, location of food reserves at different growth stages, and the effects of defoliation on the recovery of the species will facilitate the formulation of grazing methods and of sward husbandry better calculated to ensure the productivity and persistence of the pasture swards. He cited examples of the striking effects produced by varying the intensity and the frequency of grazing on pasture yield, and emphasized the importance of relatively long rest periods in influencing sheep carrying capacity on *Phalaris*—Wimmera ryegrass—subterranean clover pastures.

Mr. E. F. Fricke referred to investigations in Tasmania which indicated the desirability of associating the grazing of cattle with that of sheep to ensure the fullest use of pasturage.

Professor R. D. Watt stressed the vital need for close co-operation between State and Commonwealth Departments in the investigation of pasture problems.

Professor J. K. Murray referred to the comparatively rapid progress of pasture improvement in temperate portions of Australia, and the obvious need for stimulating pasture research in subtropical regions of Australia where the opportunities for development were considerable and the problems of development were urgent from the viewpoint both of settlement and also of defence.

Sir John Russell explained the marked effects of fertilizers on the botanical composition of pasture land at Rothamsted. On the Rothamsted Park grass plots established in 1858, the unmanured plots consisted of many species, well distributed among grasses, leguminous and miscellaneous plants, with various species indicative of poverty. A fairly uniform grass field had been changed into some fifteen different floral types merely by varying the manurial treatment. The changes in botanical composition were determined primarily by the fertilizers applied, but they were also modified by weather conditions.

A converse experiment commenced some ten years ago showed that when uniform methods of management were applied to paddocks that were sown with different grass mixtures, the differences in flora gradually diminished and in time almost disappeared. Thus grasses and clovers occurred in approximately the same proportions on all plots irrespective of the original grass mixture.

Sir John emphasized the importance of pasture research in Australia as a basic need for the development of the animal industries.

In closing the debate, Dr. A. E. V. Richardson stated that several important conclusions had emerged from the discussion. The pasture sward must be regarded as a dynamic plant community profoundly influenced by the interplay of the climatic, edaphic, and biotic factors of the environment. The climatic factor played a major role in determining the nature of the plant associations that could be established in any given region.

The delineation of agro-climatic regions, in accordance with the period of influential rainfall, and the soil moisture and temperature relationships during the growing season, had been accomplished for the winter rainfall areas of Australia, and it was now desirable to determine how far these concepts could be applied to the regions of summer rainfall.

It had been shown that the edaphic or soil factors could be modified to some extent by fertilizers, by changing the soil reaction, and by cultivation.

The factor which was most easily controllable was the biotic—the influence that could be exerted through the grazing animal by varying the intensity, the time, and the form of grazing, and by varying the length of the time interval between grazings.

A striking feature brought out in the discussion was the extent to which the carrying capacity of a pasture could be modified by these biotic influences.

The development of sound grazing methods was really dependent upon fuller knowledge of the physiology of individual pasture species and their reaction, both as individual species and components in the pasture association, to defoliation at varying growth stages by the grazing animal.

The most promising avenue for developing improved strains of naturally cross-pollinated grasses was ecotypical selection based on the most comprehensive collection of material from as wide a range of environment as possible.

There was general agreement with the view that intensive research on pasture problems, including pasture plant introduction, pasture plant breeding, pasture management, was fundamental to the rapid development of the livestock industry of Australia.

New Zealand Grassland Association

The following papers were among those presented to the eighth conference, held at Canterbury Agricultural College, Lincoln, from Oct. 31 to Nov. 2, 1939.

Greenall, A. F. The control of the *Odontria* and *Porina* grass-grubs.

Lynch, P. Review of pasture topdressing trials carried out in Canterbury by the Department of Agriculture.

Stafford and Copland. Irrigation in Canterbury.

Burns. Deterioration of cropping land.

Cameron, A. C. Organized labour in farming, with special reference to war-time conditions.

Levy, E. Bruce. Address on grassland work.

Claridge, J. H. Seed production and certification.

The papers were followed by a discussion of the farm production position during the war period and of ways and means of securing the best possible efficiency in respect of such production during the period.

Abstracts of the above papers will appear in due course.

Conference of Directors of Experiments, Sweden, 1939

The Conference opened in Stockholm on November 13. O. Franck gave an address on: providing for the nutritive requirements of plants under present conditions. A discussion followed in which A. Zachrison, Å. Åkerman, G. Torstensson and A. Elofson took part. H. Winkler gave a detailed account of the Flahult Experiment Station—its work and methods. Flahult is the oldest experiment station in Sweden. In the sphere of pasture management Flahult has led the way. Some of its pastures have been subject to control for forty years, and in 1915 von Feilitzen enunciated principles which apply to pasture management even to-day. A Persson gave an interesting address on experiences of experimental work in the province of Halland. In 1920 the number of experiments was sixteen; this year it is 200.

On the following day, November 14, the first address was given by A. von Ahn, who dealt with Jämtland as an agricultural province, and local experimental work in Jämtland. J. Rasmusson followed with an address on some suggestions for the simplification of local field experiments. G. Bjälfve dealt with current questions in legume cultivation.

American Association for the Advancement of Science.

The report of the 105th meeting (the third in Columbus, Ohio) of the Association appears in *Science*. Vol. 91. No. 2353. pp. 101-24. 1940.

American Society of Plant Physiologists

The following papers were among those presented to the sixteenth annual meeting of the Society, held at Columbus, Ohio, from Dec. 28 to 30, 1939.

Lyon, C. J. Improvements in the simplified method for osmotic measurements.

Luyet, B. J. and Galos, G. The effect of rate of cooling on the freezing point of living tissues.

Wallace, R. H. and Clum, H. H. Leaf temperatures.

———— A recording potentiometer for physiological investigations.

Went, F. W. Analysis of plant growth under controlled conditions.

Weintraub, R. L. Cultivation of excised oat leaves.

Pool, R. J. White man versus the prairie. Address of the retiring Vice-President for Section G.

Reddick, D. Problems in breeding for disease resistance.

McClintock, Barbara. Recent investigations in the cytogenetics of maize.

Loehwing, W. F. Address of the retiring President. "The effect of mineral nutrients on flower physiology."

Thut, H. F. and Loomis, W. E. Relation of light to growth of plants.

Withrow, R. B. and Withrow, Alice P. Effect of various wavebands of visible radiation on the morphology of red kidney bean seedlings.

Withrow, Alice P. and Withrow, R. B. Effect of various wavebands of visible radiation on the photoperiodic responses of certain long-day and short-day plants.

Smith, G. F. and Kersten, H. Root modifications induced by irradiation of dormant seeds with soft X-rays.

Baten, W. D. Effects of a magnetic field upon the growth of wheat.

Berry, L. D. Spontaneous variations in the electrical potentials of the root of *Allium cepa*.

Beck, W. A. Geotropic reaction in *Helianthus* seedlings.

Physiological processes of plants in relation to temperature.

Kramer, P. J. Temperature in relation to the absorption of water.

Hoagland, D. R. Temperature in relation to the absorption of solutes.

Heinicke, A. J. Temperature in relation to photosynthesis.

Thompson, H. C. Temperature in relation to reproductive and vegetative development.

Roberts, R. H. Temperature in relation to photoperiodism.

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Sayre, J. D. Storage tests with sweet corn.

Converse, C. D. and Gammon, N. Jr. The use of ion exchange materials in physiologic studies of corn.

Webster, J. E. and Mitchell, H. Determination of the nitrogen fractions in Atlas and Milo Sorghum plants.

Harvey, P. H. Intraspecific variation of nutritional requirements.

Eaton, S. M. Sulfur deficiency and the re-utilization of organic compounds in the sunflower.

Morris, V. H., Neiswander, C. R., and Sayre, J. D. Toxicity of selenium-containing plants to red spiders as a means of control.

Shear, G. M. and Ussery, H. D. What becomes of the toxic elements in plants ?

Eastwood, T. M. Toxicity of some antiseptics upon red kidney bean and tomato.

Sayre, J. D. The relation of stomata to dry weight production in corn.

————and Morris, V. H. Composition of corn stems in relation to stalk rot.

Rogers, C. F. Relation of size, age, and position of Sudan grass leaves to their content of HCN.

Northen, H. T. Studies on the protoplasmic nature of stimulation and anaethesia.

There was in addition a symposium on photosynthesis.

Ecological Society of America

The programme of the twenty-fifth annual meeting held at Columbus, Ohio, from December 27 to 30 contained the following papers, among others (abstracts appear in *Herb. Abstr.*).

Boyd, I. L. and Aikman, J. M. Studies in the establishment of native prairie grasses on eroded soils.

Brown, D. M. Successional trends in secondary succession stages on eroded soils.

Warner, R. M. Root studies in secondary succession stages on eroded soils.

Campbell, R. S. Ecology as applied to range research objectives and techniques.

Shantz, H. L. The relation of plant ecology to human ecology.

Oosting, H. J. and Humphreys, Mary E. Buried viable seeds in the forest floor of a series of stands representing stages of succession from old field to climax.

Weaver, J. E. Deterioration of mid-western ranges.

——————— and Albertson, F.W. Deterioration of grassland from stability to denudation with decrease in soil moisture.

Sperry, T. M. A quadrat study of prairie and forest plantings.

Aikman, J. M. The effect of aspect of slope on climatic factors.

Thornthwaite, C. W. Atmospheric moisture in relation to ecological problems.

Vorhies, C. T. A unique solution of the range rodent problem.

Wiggins, I. L. Salt marsh plants in relation to tide levels on the Californian coast.

Stork, H. E. Desert flora of northern Peru in an exceptionally rainy year.

Jackson, J. R. and Smith, E. V. Development of the nutgrass plant.

Dittmer, H. J. A comparative study of the subterranean members of several crop plants.

Whitman, W., Hanson, H. C. and Peterson, R. Changes in grassland vegetation in western North Dakota 1932 through 1939.

Egler, F. E. Plant ecology ; the two uses of the term.

Ramaley, F. Vegetation of a high mountain valley in Southern Colorado.

Booth, W. E. Unrecognized initial stage of plant succession and its prominence in soil erosion control in the South-central United States.

ANNOTATIONS

British Commonwealth (41/42-44)

Empire Cotton Growing Corporation

Progress reports from Experiment Stations are available for the seasons 1934-5, 1935-6 and 1936-7.

The reports from the Cotton Research Station, Biloela, Queensland, contain an account of cotton yields following certain fodder crops. There is a tendency for an increase in cotton yield to be obtained in a season with a dry second half where cotton follows Giant panicum, saccaline, sorghum, Sudan grass and maize. Thus climatic conditions determine the gain resulting from rotation with ordinary fodder crops. In regard to Rhodes grass, however, the experiments show that some gain may be anticipated where cotton follows Rhodes grass in both the first and second year after ploughing the grass. Results so far obtained in the rotation studies indicate that none of the ordinary fodder crops which can be grown in the Callide Valley gives any consistent economic benefits to the cotton grower, but where cotton is grown in rotation with grassland there is possibility of improving the returns realized from cotton, as well as obtaining good values from the grassland both as hay and for grazing purposes.

At certain Cotton Experiment Stations in South Africa, rotation crop trials are in progress with cotton, sunflowers, maize, soybeans, tepary beans, groundnuts and sorghum. The value of Elephant grass as a fallow crop in Uganda has been under trial at the Bukalasa Experiment Station. Under the native system, land is left fallow for seven to ten years, but shortage of land now makes this practice impossible and the Agricultural Department have found that by *planting* Elephant grass instead of waiting for natural regeneration, the resting period can be reduced to three years—an almost perfect stand of grass being obtained about four months from the date of planting. After three years of such a fallow, the soil is in excellent condition and high yields are obtained from all crops, including cotton, groundnuts, simsim and tobacco.

In Tanganyika the maintenance of soil fertility of the native holdings and the feeding of stock in mixed farming practice are problems receiving attention. Cattle can be kept in condition with the limited amount of grazing available by feeding crop residues such as maize stover, groundnut haulms, etc. Elephant grass, *Dolichos*, ironbark pumpkin and millet hay are other useful fodder crops. At the Lubaga Experimental Station a five-course rotation has been introduced to meet farm requirements. It is designed to restore soil fertility, to allow for seed production and stock feed. The crops include millets, *Dolichos*, *Vigna*, *Cajanus* and maize.

On the Corporation's Seed Farm at Daudawa, Nigeria, a cropping policy has been adopted with the object of (1) improving average yields, and (2) improving the general condition of the farm through grass fallowing and manuring.

Malta (458.2)

Department of Agriculture

The report for 1937-8 records that total area under forages amounted to 9,727 acres compared with 9,720 acres in the preceding ten years. Oats as grain are suitable for any class of stock and as green forage they are preferable to barley since succulence is retained to a much later

stage of maturity. Trials are in progress of the most promising five of fourteen varieties supplied by the New England Experiment Station, New South Wales.

Maize is used as green fodder for animals during summer, production for the year under review being 6,950 qrs.

Sweden (485)

State Agricultural Experiment Institute, Upsala

From January 1st, 1939, the Swedish Central Agricultural Experiment Station (Experimentalfältet) has formed a department, entitled the State Agricultural Experiment Institute, of the Agricultural College of Sweden, Upsala.

The distribution and exchange of publications will be continued by the Agricultural College, for which purpose it is asked that the former address, namely, Swedish Central Agricultural Experiment Station, Experimentalfältet, be changed for : The Agricultural College, The Library, Upsala.—G.M.R.

Netherlands (492)

Report on Agriculture

The Report for 1938 (*Versl. Dir. Landb., 'sGrav.* No. 2. 1939) notes that red clover crops were below the average except in the Provinces of Groningen and North Holland and the river clay district. Of the total area occupied by white clover, namely, 2,835 hectares, 2,404 hectares were situated in the Province of Groningen. White clover seed yield in this Province was very good, as much as 300 kg. per hectare being obtained in some parts. Lucerne (2,000 hectares) gave good yield. Clover grown in stubble suffered from drought in August, and seed clover in Limburg was badly affected by drought when the second cut was developing, for which reason seed yield was below the average and the quality left to be desired. Average hay yields were obtained, the quality of the hay being very satisfactory.

From the new Wieringermeer land satisfactory grass growth is recorded, although the mean yield of hay (first cut) was lower than that of the previous year. Infiltration of the sand grasslands was carried out at the end of April, on account of drought. Of the clovers sown, red clover gave good and lucerne fairly good yield, but white clover a relatively poor stand.

Phytopathological Service

The following damage to herbage and forage crops is recorded in the Report of the Phytopathological Service for 1938 (*Versl. Med. Plantenziektenk. Dienst.* No. 93. 1939). *Medicago lupulina* : injury by gall midges. *Medicago* : infection of lucerne by *Diplodina medicaginis* Oud. is recorded from one locality. Although this fungus produces no very serious injury, it is considered advisable to mow and carry an infected stand, so that a sound second crop may be obtained. *Festuca* : serious injury by *Pediculopsis graminum* Reut. The species most seriously affected are *F. arenaria* and *F. rubra*.—G.M.R.

Italian Africa (61)

Land Development and Conservation

The Italian agriculturists are deservedly famous for their schemes of soil and water conservation on the plains, hills and mountains of Italy itself (see Oliva, *Herb. Abstr.* 10. Abs. No. 554,

1940), and it is only natural that they should be very conscious of the potential dangers from erosion in the new areas which are being opened up for cultivation in North and East Africa. G. R. Giglioli, of the Istituto Agricolo Coloniale Italiano, Firenze (Florence), has published a monograph on " The erosion of agricultural land in the tropics " (L'erosione del terreno agrario nei tropici. Relazioni e Monografie Agrario-Coloniali. No. 49. 24 × 17. pp. 95.)

In the preface contributed by A. Maugini, it is stated that the development of colonization in tropical countries leads to the formation of new relations and a new equilibrium between native and colonist, not only in the political and social sphere, but also in the economic and technical. One of the most characteristic phenomena is the great extension of cultivated land at the expense of natural grasslands and forest areas ; thus ploughed land increases while plant cover decreases. In this ploughed land, the phenomena of erosion can attain far more serious proportions. That the presence of the colonist must be accompanied by a more intense form of economic activity is not disputed, particularly in the case of Italy, for which the exploitation of new lands is an urgent necessity.

The work by Giglioli under review is intended as an exposition of the principal aspects of the problem and a statement of the methods which can be adopted to reduce losses due to erosion to a minimum. The soils of Lybia tend to suffer from wind erosion. A special technique has been adopted in Tripolitania for fixing the dunes and for constructing windbreaks. These methods ensure a marked degree of soil defence in the whole coastal region of Gefara ; three plantations of olives and almonds, in particular, break the force of the winds and reduce the surface erosion.

With the recent discovery of subterranean and artesian waters, irrigation will become increasingly important, and the relation between dry farming and irrigated agriculture will be considerably modified, to the advantage of the conservation of the soil.

In the territories of Italian East Africa, the erosion problem is quite different, owing to great differences in climate, the topography, and the nature of the soils. The knowledge on the subject is still very limited, but it is obvious that the methods of conservation to be adopted will be extremely diverse. For example, figures are not yet available regarding the intensity and frequency of rainfall. It is, however, quite certain that the predominant characteristic of Italian East Africa is violent rainstorms of short duration, taking place at relatively high temperatures. Neither are complete data available regarding the soils, but in general it may be said that the surface of the soils of the high plains tends to " puddle" at the time of the first rains, thus increasing run-off and favouring erosion.

With the development of agriculture in the country, the relationship between cultivated land and natural pasturage will be modified. There will be thus a tendency for the stock-raising industry to change from a nomadic to a stationary type, with the consequent necessity to adjust carrying capacity, to rest pastures at intervals, to terrace when necessary and to provide more and scattered waterholes, all to ensure that the new type of management shall not lead to destruction of vegetation and erosion of the soil. In the development of the cultivated land, it will also be necessary to adopt suitable methods of ploughing, cultivation, terracing, etc., and to introduce the proper type of rotations, cover crops, green manure plants, etc.

" Italy is applying herself to a task which, for its vastness, for the territories in which it is to be developed, and for the final aim which it sets before itself, is quite without precedent. She is above all possessed of two great forces ; a disciplined and thrifty agricultural population and an Authoritarian State which looks far enough ahead, which knows what it wants, and which subordinates all private interests to the greatness of the Fatherland."

Belgian Congo (675)

National Institute for Agronomic Studies

Current research conducted at different Stations of the National Institute for Agronomic Studies in the Belgian Congo is reported in *Agric. Elev. Congo Belge*, Vol. 13, pp. 61, 64, 143, 144, 158 and 159, 1939, and includes the following work.

Bambesa Experiment Station. Trials of *Pennisetum purpureum* for the regeneration of exhausted soils, dating from 1935, have proved this grass to be very effective for the purpose, and it is considered that its presence in a rational rotation is indispensable. A local variety was originally employed, but a more hardy and vigorous variety from the Yangambi region has been recently introduced and is being reproduced on a large scale.

Yangambi Plantation. Centrosema and *Pueraria*, grown in a mixture as cover crop, are reported to be well developed, the latter by far surpassing the former.

Kisozi Experiment Station. The following varieties of lupin are cultivated : *Lupinus varius*, *L. luteus*, *L. albus*, *L. albus* (large variety), a small lupin, *L. polyphyllus*, and a commercial hybrid fodder legume. *L. luteus* and the fodder legume give the best results. The large white lupin also gives good yield, but its growth is much slower than that of the yellow lupin, nor is it so resistant to arid conditions. No growth can be obtained from *L. polyphyllus*. The yellow fodder lupin, which has a vegetation period of six and a half months and has given a grain yield of 447 to 753 kg. per hectare, is greatly appreciated by cattle. As soon as sufficient seed of this lupin is available, the cultivation of the old yellow lupin will be abandoned. Of the remaining varieties, only small plots for seed are now grown.

At this Station two hectares of land more or less degraded by erosion were planted with *Pennisetum* early in 1938, and certain completely denuded areas were covered with branches of brushwood in flower, all with remarkably successful results. Other measures incorporated in the anti-erosion campaign of 1937 and 1938 are noted. Results have been satisfactory, but the work is found to entail much labour.

Nyamyaga Experiment Farm, Ruanda-Urundi. Ensilage in a simple trench, 3 metres deep and 3 metres in diameter, has been found easy and inexpensive to carry out, and to furnish the only method at present available for ensuring that cattle shall be in a good condition during the dry season.

Nioka Experiment Station. Mulching with lupins and *Phaseolus*, although somewhat inadequate in quantity, was found satisfactory in protecting the soil of young coffee plantations from the heating and evaporation which are particularly intense in the dry season.

Experiments in contour cropping with slips of *Pennisetum* and *Vetiveria zizanioides* Nash gave successful results. The former becomes readily established and puts a rapid stop to gullying : the latter is deep-rooting and has the advantage over *Pennisetum* of not growing so tall. Trials of *Leucaena* and other legumes for soil binding are to be undertaken.—G.M.R.

South Africa (68)

Dr. I. B. Pole Evans

According to the Kew Bulletin No. 10, 1939, Dr. I. B. Pole Evans, Chief of the Division of Plant Industry, Department of Agriculture and Forestry, has retired under the age limit. The Divisions of Plant Industry and Agricultural Education and Extension have been replaced by five new divisions as follows :

Animal and Crop Production ; Soil and Veld Conservation ; Horticulture ; Entomology ; Botany and Plant Pathology. Dr. E. P. Phillips, M.A., D.Sc., has been appointed Chief of the new Division of Botany and Plant Pathology.

Dr. E. Percy Phillips

Dr. E. Percy Phillips has been appointed Chief of the newly-created Division of Botany and Plant Pathology. " As a botanical research worker, he occupies an outstanding position in South Africa, as he is the author of the following standard works of reference relating to South African botany :—

(a) Genera of South African flowering plants.
(b) The South African genera of grasses.
(c) The weeds of South Africa (*Herb. Abstr.* 10. No. 1. 1940).

(d) A history of botany in South Africa.
(e) Flora of Basutoland.

Besides these, he has edited the following publications :—

(f) The flowering plants of South Africa.
(g) Bothalia.
(h) Botanical Survey memoirs."

U.S.A. (73)

Revegetation by the Soil Conservation Service

The issue of *Soil Conservation* for September 1939 contains much information of interest to those concerned with the use of a protective cover in erosion control. It comprises a series of articles on revegetation methods in the regions of the Soil Conservation Service, contributed largely by the Chiefs of the Regional Agronomy Divisions. As the titles are self-explanatory, the following list will suffice :—

Brown, G. F.	Mulching north-eastern orchards.
Bailey, R. Y.	The use of kudzu on critical slopes.
Morrish, R. H.	Tennessee covers the soil for the winter.
Hodson, E. A.	Bermuda—one-time pest—now a southern favourite.
Gardner, H. H.	Protected waterways.
Watson, S. H.	Progress of regrassing in southern Great Plains.
Collins, W., Jr.	Crested wheatgrass on denuded range and " go-back " land.
Flory, E.	The role of reseeding in restoring south-western ranges.
Ahlson, C. B.	Orchard cover crops in the Pacific South-west region.
Semple, A. T.	How to use our greater acreage of hay.

Wilt-resistant alfalfa

Wilt-resistant alfalfa varieties, developed under a long-range breeding programme by the U.S. Department of Agriculture, will be available for limited distribution in 1942. The new alfalfas are being produced by crossing resistant strains, brought from Turkistan by H. L. Westover, with varieties already established in the United States. Alfalfa wilt began to present a serious problem in this country about fifteen years ago. Up to that time, a good stand of alfalfa could be counted on to last from six to twelve years without reseeding, but lately the wilt organism has been wiping out alfalfa fields in from two to four years.—Quotation from *Science*.

F. W. Tinney

According to the *Journal of the American Society of Agronomy*, Dr. F. W. Tinney and his wife were among those listed as missing after the *Athenia* was sunk off the coast of Scotland on September 3, 1939.

Dr. Tinney went to the University of Wisconsin as research assistant, which position he held until his appointment in February, 1934 as assistant agronomist in the Bureau of Plant Industry, U.S. Department of Agriculture (working in co-operation with the Department of Agronomy of the University of Wisconsin).

(See *Herb. Abstr.* 6. p. 435. 1936, and 8. Abs. No. 293. 1938 ; also *J. Amer. Soc. Agron.* 31. 1069. 1939.)—R.O.W.

Chronica Botanica

The new address of the Chronica Botanica Co., formerly of Leiden, Holland, is

c/o Arnold Arboretum,
Jamaica Plain,
Massachusetts,
U.S.A.

Brazil (81)

Report of the Ministry of Agriculture, 1938

The following sections of the Ministry's Report (Ministerio da Agricultura. Trabalhos realizados em 1938. Rio de Janeiro. 1939. pp. 520) are of interest.

The Section of Agrostology and Animal Nutrition of the Department of Animal Products has under observation and trial numerous herbage and forage plants, indigenous and exotic. Seed of suitable species is reproduced for supply to farmers, and within the year under review large quantities of seed and tillers have been distributed. The species concerned are listed on pp. 366-8. A study of the longevity of grasses and legumes is being made by means of germination trials. It is found that the indigenous species possess a large percentage of hard-coated seeds.

At the Experiment Station of the Division of Plant Products large quantities of seed of legumes (*Mucuna, Canavalia, Crotalaria*, etc.) have been produced and distributed (for list see p. 198). The Division's Station at São Simão, State of São Paulo, has been concerned with the growing and breeding of soybeans since 1921. Chemical analyses made at Hamburg showed São Simão samples to be richer in oil and protein than Manchurian soybeans. The Station's bred strain " Artofi", a cross between " Tarheel Black " (150 days) and " Aksarben " (80 days) is very rich in oil. It is considered that the climatic and edaphic conditions of Brazil are especially well suited to the cultivation of soybeans, for which there is now a great demand. Germany and Sweden are said to be disposed to purchase Brazilian soybeans, and prospective cultivators are invited to apply to the Ministry for advice.

Programmes of work for the newly created Institute of Agricultural Ecology and Institute of Agricultural Experimentation are presented on pp. 159-65.—G.M.R.

Argentine Republic (82)

Tucuman Agricultural Experiment Station

The Report of the Director for the year 1938 appears in *Rev. industr. agric. Tucuman.* 29. 5-75. 1939, and includes accounts of trials of different legumes for green manure and cover crops (p. 29), trials of *Melinis minutiflora* as a forage crop, and soybean trials. The grasses contained in the Station's herbarium have been revised and errors have been corrected. Among seed distributed gratuitously for experimentation was *Vicia atropurpurea.*—G.M.R.

Chile (83)

Agricultural Experiment Station, Santiago

A report on the work of the Station for 1937 is contained in the annual report of the National Agricultural Society. (Memoria de la Sociedad Nacional de Agricultura. Año 1937. Santiago de Chile, 1938. pp. 306.)

Maize, beans and lentils. Selection and reproduction continue. A newly acquired estate of 360 hectares is being employed for the reproduction of pedigree seed. The reproduction of lentils at the Experiment Station was not successful. Trials are now being conducted in the Haulañé zone. A trial of 134 selected lines of lentils is being made.

Soybeans. The Head of the Department of Seed Reproduction has just returned from a tour in Europe, whence he brought four German strains, namely, Bonn Yellow III, Poppelsdorf Black

Brilliant, Strain No. 150, and C.S.S. These are being tested in comparison with two strains already acclimatized in Chile, namely, Illini and Ito San. Repeated germination trials have shown germination in the four German varieties to be (in the same order) 40, 50, 20 and 65 per cent, and seeding rate is calculated in accordance therewith. An extraordinary degree of earliness distinguishes the German varieties, which develop thirty to forty-five days before the Chilean varieties, but are considerably smaller than the latter. The German varieties nevertheless yield well, especially Poppelsdorf Black Brilliant and C.S.S., and if in the course of acclimatization they do not deteriorate, they will—on account of their rapid development—be of value, particularly in regions where frost and rain are liable to endanger soybean harvests taken at the normal season. Selection is being carried out in the best varieties. Inoculation with an imported German culture has proved successful, and the inoculant has been made available for soybean growers in Chile at approximately one-third of the cost price.

Pages 145-244 of the Report are occupied by Mr. Guillermo Fonck's account of his European study tour. Included in the subjects of study were the cultivation of soybeans and other oil plants, forage crop research, and the cultivation of lupins, sweet lupins in particular. The last-named subject was studied at Müncheberg and Landsberg in Germany. It is considered that the lupin would probably be of value as a forage plant in acid volcanic soils in the south of Chile and in the sandy coastal soils (where the latter are sufficiently moist). Five species of *Lupinus* grow wild in Chile, and it is possible that the species *mutabilis*, which has been proved to contain alkaloid-free forms in the Müncheberg investigations, may also be found in the northern part of the Chilean Andes. A full account is given of the present position of sweet lupin improvement, of lupin cultivation and the requisite conditions, and of its prospects in Chile.—G.M.R.

Uruguay (899)

National Commission for the Study of the Forage Problem

The Commission, which is under the Presidency of Dr. A. Boerger, Director of the Institute of La Estanzuela, was appointed in 1936 (see *Herb. Rev.* 4. 78-81. 1936). The Bureau has now received reports on the first two years' work. Of the first report, published in 1938*, an abstract is available. The following is an outline of the second report, which has been received from the President of the Commission†.

Study of the pastures of Uruguay. In continuance of the detailed examination, zone by zone, of the country's grassland resources, soil studies have been made of areas characterized by a deficiency of phosphorus and calcium, especially those on which experiments in the administration of "Fosfosal", a mineral lick, have been made on a large scale. The results have been published in a pamphlet entitled "Result of experiments in the administration of 'Fosfosal' on grazings where osteomalacia has been prevalent", by L. A. Montedónico, C. A. Fynn and F. O. Vedani [*Herb. Abstr.* 10. No. 1. 1940.] For the same purpose interesting observations have been made on natural pastures in the Department of Artigas, situated on land which is good but liable—on account of its stony nature—to be severely affected by drought, in comparison with poor pastures in the Departments of Treinta y Tres and Cerro Largo. The results of this study are set forth in a publication by G. E. Spangenberg and E. Riet, entitled "Incidental and permanent nutritional deficiencies of natural pastures" [*Herb. Abstr.* 10. No. 1. 1940].

*Uruguay, Ministerio de Ganadería y Agricultura. Memoria de trabajos realizados por la Comisión Nacional de Estudio del Problema Forrajero en el año 1937-38. Montevideo, 1938. pp. 12.

†Boerger, A. Resumen de la memoria de los trabajos efectuados por la Comisión Nacional de Estudio del Problema Forrajero en 1938-39. Montevideo, 1939. [Typescript.] pp. 8.

Study of the soils. One hundred analyses of soil and four of rock have been made during the year, bringing up the total number of soil analyses to 303. An equal number of botanical analyses of the herbage, corresponding to these soil analyses, have also been made, so that during the course of the year [1939] there will be completed—for the whole network of observational centres established throughout the country—all the analyses to be made for determining the correlations that exist between the nutritive value of grasslands on the one hand and the quality of the land and nature of the climate on the other.

Experiments in the administration of "Fosfosal".—There have been distributed to date 31,000 kg. "Fosfosal", a mineral lick, for experimental purposes. Detailed information on the entirely satisfactory results of these trials is contained in the pamphlet referred to above.

Forage foresight. There have been ensiled 3,638 tons of forage in sixty-three silos, giving an average of almost sixty tons per silo. The silage was composed as follows:

Number of silos.	*Crop plant used.*	*Silage in tons.*
44	maize	2,531
15	cardoon (*Cynara cardunculus*)	815.5
3	oats	122
1	lucerne	130

Silos have been erected principally in the Departments of Flores, Colonia, Soriano, Tacuarembó and Florida.

Experiments in the fattening of steers. A comparative trial of temporary leys of oats and *Lolium* respectively has been made.

Sheep breeding and fattening trials. Through the personnel of the Seeds Section of the Official Seed Distribution Service, as in the previous experiment, experiments in the breeding and fattening of sheep have been continued this year in leys composed respectively of oats, of ryegrass, of oats-ryegrass mixtures, and of ryegrass and *Medicago lupulina.*

J. G. Nores, Technical Assistant to the Commission, has also carried out interesting experiments in the fattening of sheep in rape leys on three different ranches, with satisfactory results [*Herb. Abstr.* 10. No. 1. 1940].

Comparison of rape and oat leys for the fattening of sheep. The area occupied by rape for experiment purposes is as follows: Department of Flores, total area of 28 hectares, situated on four ranches; Department of Durazno, total area of 55 hectares, situated on four ranches; in addition two ranches in Rio Negro, two in Paysandu and one in Salto.

Fodder beet trials. A total area of forty-seven hectares has been established on various ranches in the Departments of Flores, Durazno, Paysandu, Soriano, and Canelones. A Technical Assistant, L. A. Montedónico, has been detailed to take charge of the feeding trials concerned in these experiments. The Seeds Section of the Official Distribution Service are co-operating in this work.

Lucerne sowings. Experiments in the establishment of lucerne continue at the Station of La Sierra under the Seeds Section of the Official Seed Distribution Service, working in close co-operation with the National Commission.

Adaptation of forage plants. With the financial assistance of the Commission, acclimatization experiments at La Estanzuela under the charge of T. Henry are being extended, not only in regard to the general behaviour of herbage and forage plants, but also in regard to their tolerance of grazing and their value for fattening.

Laboratory for nutritional studies. This Laboratory, established with the co-operation of the National Commission, has been studying coefficients of digestibility in different valuable forage plants, and at the same time has been conducting feeding trials, the results of which will shortly be published.

Distribution of seeds. In order to demonstrate the advantages of growing valuable forage crops, the following seed has been distributed gratuitously:

Helianthus tuberosus	2,000	kg.
Pennisetum purpureum	37,500	plants
Grohoma sorgo	300	kg.
Andropogon sorghum var. *Sudanensis*	1,000	,,
Avena byzantina	1,300	,,
Rieti fodder wheat	1,500	,,
fodder barley, 702a	300	,,
Lolium perenne	100	,,
Phalaris minor	100	,,
rape	2,000	,,
fodder beet	250	,,
millet (milo)	4,270	,,

Report of a tour of inspection. On the 2nd April, 1939, the President, together with Engineer T. Henry, started on a tour of inspection in the interior. Dairy farmers throughout the country were found to be greatly interested in the sowing of millet (milo), on account of its resistance to drought, its practical immunity to locust attack, and the facility with which it can be converted into silage. For this reason 4,370 kgs. seed of Grohoma sorgo are to be distributed next September to forty-eight ranches (listed) in different parts of the country. Each ranch is building a silo for the purpose of ensiling the crops obtained from this seed.

In addition to this large demand for millet seed, requests have been received for 2,000 plants of *Pennisetum purpureum*, to be sent to the north of Uruguay by the end of September, to the south by the beginning of October. A further request is for 35 kg. *Chloris gayana* seed, for the purpose of suppressing *Sorghum halepense*. Rape seed (1,110 kg.) and seed of fodder beet (315 kg.) was distributed in March and April, 1939. Rape has been found a successful crop for sheep rearing.

The mineral lick "Fosfosal" is being distributed at the rate of 1,700 kg. monthly, with successful results.

Twelve silos, with a capacity of 1,014 tons, have recently been erected for the ensilage of maize. They are listed (note of owner, locality, and capacity).

Sowings of rape for feeding trials in different parts of Uruguay are listed, with a note of the date of sowing and particular purpose of the trial; and seven fodder beet trials are listed.—G.M.R.

New Zealand (931)

Cawthron Institute

The Government decided to establish 200 acres of pasture on the Buller Domain, Sergeant's Hill, Westport, under the Pakihi land reclamation scheme. (See Reports of the Cawthron Institute Nelson, for the years 1936-8.) During 1936 this establishment was completed and the reclamation project was enlarged. In 1937 sowing of pasture was completed on 800 acres of the development scheme. The take of grass has been excellent and yields of hay from 2.5 to 3 tons per acre were not infrequent. The condition of grazing calves indicates a deficiency of cobalt, but on the whole the stock made satisfactory live-weight gains.

The reports include results of pasture fertilizer trials, the use of cobalt salts in controlling bush sickness and allied stock ailments in the South Island (see *Herb. Abstr.* 8. Abs. 477. 1938), the increase in *Medicago* acreage due to the facilities at the Institute for distribution of lucerne bacterial cultures, and experiments in biological control of certain weeds, notably piripiri (*Acaena novae-zelandiae*), *Senecio jacobaea* and *Ulex* sp.

SEED EXCHANGE

Brussels, Belgium

Seeds offered from the 1939 collection of the State Botanic Garden, Brussels, Belgium.

Gramineae

Aegilops ovata L.
A. speltoides Tausch.
Agropyrum caninum Beauv.
Agrostis alba L. var. *stolonifera* Pirl et Mull.
A. rupestris All.
A. vulgaris With.
Alopecurus agrestis L.
A. arundinaceus Poir.
A. geniculatus L.
A. pratensis L.
A. ventricosus Huds.
Andropogon Ischaemum L.
A. Sorghum Roxb.
Arrhenatherum elatius Beauv.
Avena fatua L.
A. orientalis Schreb.

Briza geniculata Thunb.
B. maxima L.
B. media L.
B. minor L.
Bromus arvensis L.
B. carinatus Hook.
B. commutatus Schrad.
B. erectus Huds.
B. macrostachys Desf.
B. madritensis L.
B. maximus Desf.
B. secalinus L.
B. sterilis L.

Calamagrostis epigeios Roth.
Coix Lacryma-Jobi L.
Cynosurus cristatus L.
C. echinatus L.

Dactylis glomerata L.
Dactyloctenium mucronatum Willd.
Deschampsia caespitosa Beauv.
D. flexuosa Trin.

Eleusine coracana Gaertn.
Elymus arenarius L.
Eragrostis pilosa Beauv.

Festuca geniculata Cav.
F. heterophylla Lam.
F. ovina L.
F. pratensis Huds.

Festuca pseudovina Hack.
F. rubra L.

Glyceria distans Wahlb.

Holcus lanatus L.
H. mollis L.
Hordeum bulbosum L.
H. hexastichon L.
H. murinum L.
H. sativum Pers.
H. vulgare L.

Koeleria cristata Pers.
K. phleoides Pers.
K. setacea D.C.

Lamarckia aurea Moench.
Lolium multiflorum Lam.
L. perenne L.
L. remotum Schrank.
L. temulentum L.

Molinia caerulea Moench.
Muehlenbergia glomerata Trin.
M. pendula Bong.

Nardus stricta L.

Paspalum vaginatum Sw.
Phleum pratense L.
Poa compressa L.
P. langigera Neis.
P. nemoralis L.
P. pratensis L.
P. serotina Ehrb.
P. trivialis L.

Setaria italica Beauv.
S. verticillata Beauv.
S. viridis (L.) P. Beauv.
Stipa Calamagrostis Vahl.
S. splendens Trin.

Trigonella coerulea Ser.
Tripsacum dactyloides L.
Trisetum flavescens P. Beauv.
T. macrotrichum Hack.

Zea Mays L.

Leguminosae.

Astragalus Cicer L.
A. galegiformis L.
A. gummifer Labill.
A. glycyphyllos L.
A. Robbinsii A. Gray
A. Tragacantha Pall.

Glycine hispida Maxim.
G. Soja Sieb. et Zucc.

Indigofera floribunda Hort.

Lespedeza macrocarpa Bunge.

Medicago apiculata Willd.
M. falcata L.
M. lupulina L.
M. minima L.
M. orbicularis All.
M. sativa L.
M. tuberculata Willd.
Melilotus alba Desr.
M. officinalis Lam.

Onobrychis montana DC.
Ornithopus sativus Brot.

Trifolium alpestre L. (flore albo)
T. montanum L.
T. repens L.

Vicia amphicarpa D.
V. Cracca L.
V. Ervilia Willd.
V. Faba L.
V. lutea L.
V. picta Fisch. et Mey.
V. sativa L.

Miscellaneous.

Atriplex hortensis L.
A. rosea L.
A. sibrica L.

Helianthus annuus L.

Sofia, Bulgaria

Seeds offered from the 1939 collection made at the Faculty of Agriculture, Sofia University, Bulgaria.

Gramineae

Agropyron glaucum P.B.
A. villosum Link.
Agrostis alba L.
A. canina L.
A. vulgaris With.
Alopecurus pratensis L.
Andropogon sorghum Brot.
Arrhenatherum elatius M.K.

Briza maxima L.
B. media L.
Bromus secalinus L.
B. transsylvanicus Steud.

Dactylis aschersoniana Gr.
D. glomerata L.
Deschampsia caespitosa P.B.
D. flexuosa Trin.

Festuca duriuscula L.
F. elatior L.
F. Halleri All.
F. ovina L. var. *glauca*
F. rubra L.
F. valesiaca Schleich.

Holcus lanatus L.
H. mollis L.

Lupinus albus L.
L. augustifolius L.
L. hybridus Lem.
L. polyphyllius

Phleum Michelii All.
P. pratense L.
P. pratense L. v. *nodosa*
Poa compressa L.
P. nemoralis L.
P. violacea Bell.

Leguminosae

Astragalus armeniacus Boiss.
A. glycyphyllus L.
A. odoratus Lam.

Cicer arietinum L.

Lathyrus cicera L.
L. odoratus L.
L. vernus Bernh.

Medicago falcata L.
M. sativa L.

Melilotus albus Lam.
M. officinalis Lam.
M. segetalis Ser.

Onobrychis lasiostachya Boiss.

Soja hispida Moench.

Trifolium heldreichianum Huds.
T. montanum L.
T. panormitanum Presl.
T. pratense L.

Trigonella Foenum graecum L.

Miscellaneous

Atriplex hortensis L.

Turin, Italy

Seeds obtained from the 1939 collection made at the Botanical Garden, Viale Mattioli No. 31 al Valentino, Turin, Italy.

Gramineae

Alopecurus pratensis L.
Andropogon Ischaemon L.
Anthoxanthum odoratum L.
Arrhenatherum elatius K. et M.
Avena sativa L.

Bromus sterilis L.

Coix Lacryma Jobi L.

Dactylis glomerata L.
Diarrhenia americana Beauv.
Deschampsia caespitosa P.B.

Eleusine japonica Steud.
Eragrostis nebulosa Boiss.

Festuca amethystina L.
F. arundinacea Vill.
F. bromoides L.
F. elatior L.
var. *pratensis* Huds.
F. ovina L. var. *capillata* Lam.
var. *duriuscula* L.
var. *glauca* Lam.
var. *glaucescens*
var. *Halleri* All.
var. *heterophylla* Lam.
var. *pseudovina* Hack.
var. *rubra* L.
var. *scoparia* Hook.
F. silvatica Vill.
F. spadicea L.
F. spectabilis Jacq.
F. varia Haenke.

Hordeum exastichon L.
H. ithaburense Boiss.
H. macrolepis A. Br.
H. vulgare L.
Holcus lanatus L.

Koeleria cristata Pers.

Lolium perenne L.
L. temulentum L.

Panicum miliaceum L.
P. virgatum L.
Phalaris arundinacea L.
P. canariensis L.
Poa annua L.
P. compressa L.
P. pratensis L.

Secale cereale L.
Setaria verticillata Beauv.
Sorghum halepense Pers.
S. vulgare Pers.

Triticum dicoccum Schrad.
T. monococcum L.
T. vulgare L.

Uniola latifolia Michx.

Zea Mays L.
var. *cryptosperma*
var. *microsperma*

Leguminosae

Astragalus Cicer L.
A. falcatus Lam.
A. galegiformis L.
A. glycyphyllos L.
A. uliginosus L.

Crotalaria incana L.

Lathyrus heterophyllus L.
L. multiflorus Peterm.
L. odoratus L.
L. pratensis L.
L. sativus L.
L. silvestris L.
Lotus tenius Walld.
Lupinus albus L.
L. polyphyllos Lindl.

Medicago lupulina L.
Melilotus alba Desr.
M. officinalis Lam.

Onobrychis vicaefolia Scop.

Phaseolus multiflorus Willd.
P. vulgaris L.
Pisum arvense L.

Trifolium alpestre L.
T. arvense L.
T. badium Screb.
T. incarnatum L.
T. pannonicum Jacq.
T. repens L.
Trigonella Foenum graecum L.

Vicia aurantiaca Boiss.
V. dumetorum L.
V. Faba L.
V. narbonnensis L.
V. sativa L.
Vigna Catjang Walp.
V. sinensis Endl. var. *rubra*.

Canada—Seeds Act, 1937, and Regulations

The following list of established varietal names of grasses, clovers and forage crops is quoted from Acts, Orders and Regulations No. 24, Ottawa, September, 1939. *Denotes varieties eligible for registration.

Alfalfa

Variegated:

- Baltic
- Cossack
- *Grimm
- Hardigan
- *Ladak
- MacSel
- *Ontario variegated

Yellow flowered:

- Siberian
- Semi Palatinsk

Violet:

- Turkestan

Clovers

Red clover (*Trifolium pratense*)

Double cut or early:

- *Dollard
- Double cut hairy
- Double cut smooth
- Medium
- Montgomery
- *Ottawa

Single cut or late:

- *Altaswede
- *Manhardy
- Mammoth
- Siberian
- Swedish late

Sweet clover (*Melilotus* spp.)

White:

- Albotrea
- *Alpha
- *Arctic
- Brandon dwarf
- Grundy County
- *Melana

Yellow:

- Aura
- Erector
- Zouave

White clover (*Trifolium repens*)

Wild:

- English wild white
- Kentish wild white
- New Zealand certified
- Scottish wild white

White:

- Ladino or Mammoth
- White Dutch

Danish:

- Morsø
- Strynø

Grasses

Brome grass (*Bromus inermis*) :
*Parkland *Superior

Crested wheat grass (*Agropyron cristatum*) :
*Fairway

Orchard grass (*Dactylis glomerata*) :
Avon Olsgaard (Danish)
Hercules Skandia (Swedish)

Reed canary grass (*Phalaris arundinacea*) :
Aqua

Ryegrass (*Lolium* spp.) ;
Italian Pacey perennial

Slender wheat grass or western ryegrass (*Agropyron* sp.) :
Fyra *Mecca (Sask. 8)
Grazier

Timothy (*Phleum pratense*) :
Boon Montcalm
Dural S.50
Gloria *Swallow
Milton

Lawn or Turf Grasses

Bent grasses (*Agrostis* spp.) :
Colonial or P.E.I. bent Red top
Creeping Velvet

Bluegrasses (*Poa* spp.) :
Canadian Rough-stalked meadow
Delta Wood meadow
Kentucky

Fescues (*Festuca* spp.) ;
Red :
Chewing *Creeping red (Olds)
Sheep :
Fine-leaved Hard
Meadow :
Sturdy Tall
Various leaved :

There is also a long list of dent and flint varieties of corn, and special instructions for the importation and sale of hybrid seed corn of field varieties ; two varietal hybrids, Algonquin and Iroquois, are listed. There are also lists of soybean and field pea varieties.

Sydney, Australia

A request has been received from Dr. W. L. Waterhouse, School of Agriculture, University of Sydney, for seeds of certain species required in the study of superior fodder plants for the western low rainfall areas and southern regions of moderate rainfall but alkaline soils in New South Wales. A fairly comprehensive collection has been obtained from Australian sources of strains of " annual species of *Medicago*, early flowering varieties of *Trifolium subterraneum* and species of *Danthonia*. As many desirable factors have not yet been found, it would be of great value if arrangements could be made to get small samples of seed from the natural habitats of the various species. Seed of any of the annual medics, and of *Trifolium subterraneum* from the Mediterranean regions and the Near East might well prove most useful.

" Any seed of *Danthonia* spp. or of *Panicum antidotale* Retz. from the drier areas of the Near and Middle East should be really valuable, but material from any source would receive the most careful consideration." Seed of any of the strains already collected will be gladly sent in exchange, as far as present supplies will permit, together with the available data on each. If present stocks of seed are insufficient, further supplies will be available from later harvests.

The Bureau has undertaken a certain amount of correspondence in connexion with this enquiry, and has already obtained valuable seed samples or promises of assistance from Portugal, Malta, St. Helena, Cyprus, India and the Bureau of Plant Industry, Washington, D.C.

Any further offers of assistance will be most appreciated.

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IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS

This Bureau covers literature on grassland and forage crops, the botanical aspects of soil conservation, and certain plant biological research. It issues two quarterly journals:

HERBAGE ABSTRACTS

Annual subscription 25s., single parts 7s.

HERBAGE REVIEWS

Annual subscription 15s.,* single parts 4s.
*A reduction of 5s. allowed when *Herbage Abstracts* is also ordered.

The Bureau also issues Bulletins and Mimeographed Publications (bibliographies, etc.) at irregular intervals. Particulars of Bulletins 26, 27, 28 and 29 are given below; details of earlier issues are available on request.

BULLETIN No. 26, PUBLISHED SEPTEMBER, 1939

"Research on grassland, forage crops and the conservation of vegetation in the United States of America"

Pages: 113, maps, indexes of subjects and genera. Price: Five shillings.

BULLETIN No. 27, PUBLISHED JANUARY, 1940

"The control of weeds"

(A symposium on current research and practice in the eradication of undesirable plants in arable land, grassland, etc., by cultural, chemical and biological means.)

Contributions by: T. K. Pavlychenko and R. H. F. Manske (Canada); L. W. Kephart, A. S. Crafts, R. N. Raynor, and J. Monteith, Jr. (U.S.A.); B. Rademacher (Germany); G. A. Currie and A. P. Dodd (Australia); E. Bruce Levy and D. Miller (New Zealand); D. G. Steyn (South Africa).

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BULLETIN No. 28, PUBLISHED JANUARY, 1940

"Technique of grassland experimentation in Scandinavia and Finland"

Contributions by: G. Giöbel and K. Lundblad (Sweden); B. Sakshaug and H. Foss (Norway); H. Bögh and J. Hansen (Denmark); C. A. G. Charpentier (Finland).

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BULLETIN No. 29, PUBLISHED JANUARY, 1940

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